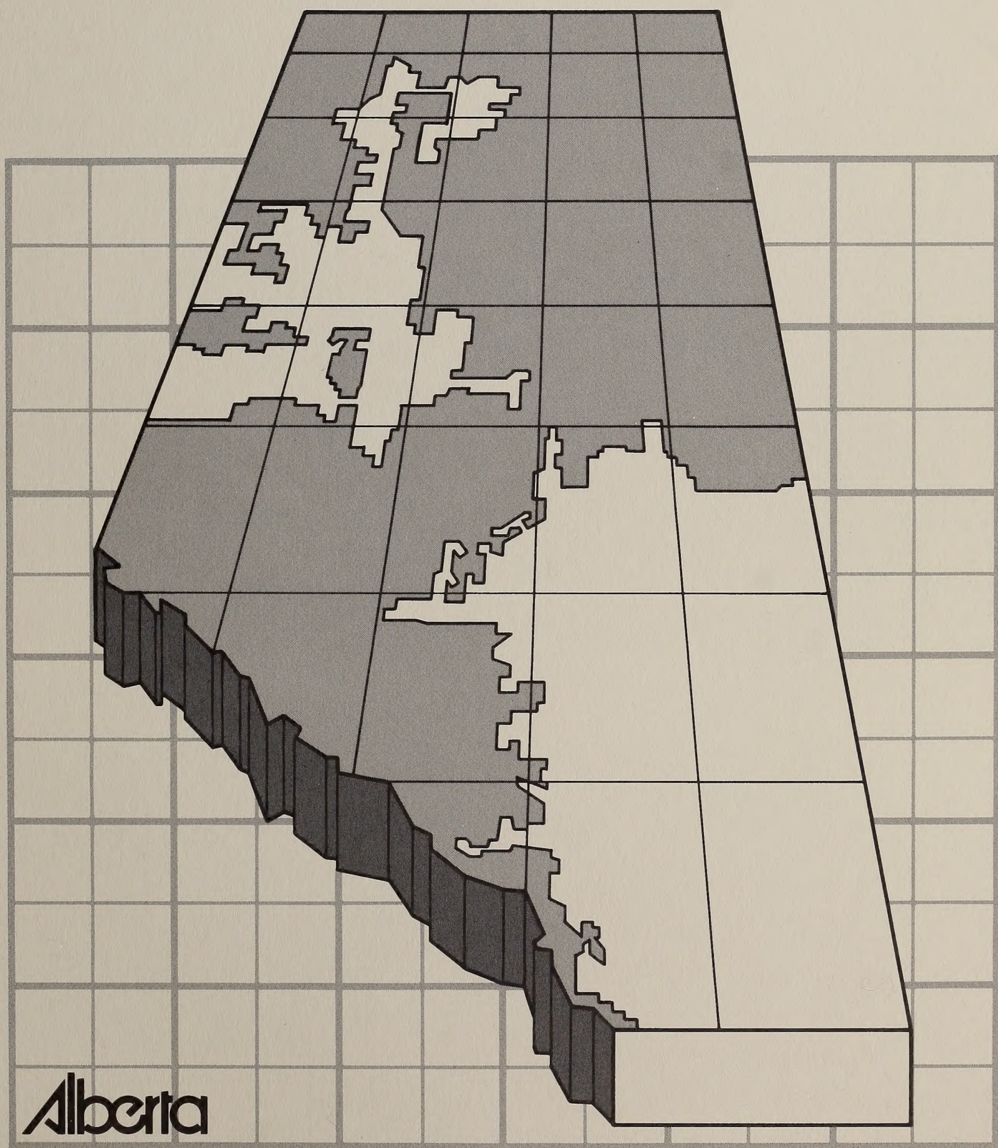
Agricultural Land Base Study

Summary



Alberta

AGRICULTURAL LAND BASE STUDY:

DEVELOPMENT OPPORTUNITIES FOR THE FUTURE

SUMMARY

Alberta
Agriculture
Environment
Forestry, Lands and Wildlife
Municipal Affairs
Transportation

Edmonton
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AGRICULTURAL LAND BASE STUDY:
DEVELOPMENT OPPORTUNITIES FOR THE FUTURE

SUMMARY REPORT

1. INTRODUCTION

1.1 Background

There are many opportunities for expanding the agricultural land base and increasing the productivity of land currently in agricultural production. These opportunities range from major land and water development projects which would require large-scale public investment, to soil conservation and reclamation opportunities which are within the scope of individual land owners. Any significant initiative to more effectively manage resources for agricultural production should recognize the various alternatives which are available, their costs and returns, and their impacts, both positive and negative, on other resource users.

While agriculture is a major resource user in Alberta, there are many other needs which are served by the natural resource base. The forestry industry is directly dependent on large areas of land, as are recreation and tourism. Wildlife populations which support recreational and commercial uses are also land and water resource based. The general management philosophy for public resources in Alberta is to promote multiple use and to strive for the maximum total benefits from sustained use.

Various suggestions for agricultural resource development have been dealt with in previous studies. Generally, these studies have taken a single, often narrow, point of view and have been focused on one approach or one portion of the province, or have not been specifically concerned with the impacts that agricultural development might have on other resource users. These suggestions and studies are inadequate for broad decision making on the direction which future resource development should take. There has been a need, therefore, for a comprehensive and comparative investigation of agricultural resource development opportunities.

In recent months considerable attention has been focused on the financial difficulties faced by many farmers. Stabilization and control of input costs and securing marketing opportunities are important needs relating to the viability of the agricultural industry in Alberta. These issues do not, however, detract from the need to undertake long-term planning for resource development. A natural resource study must deal with the major resource management alternatives rather than the major financial ones.

In 1982 an interdepartmental task force was assembled to develop an approach for determining the potential for expanding the provincial agricultural land base and increasing the intensity of production on existing agricultural land. This action was in response to growing public pressure to increase the availability of public land for agricultural production. A 1981 report by Dr. H. M. Horner recommended an increase in the land base for agriculture by bringing 10 million acres of new land into production in a 10-year period. At about the same time an advisory committee to the Government of Alberta recommended that inventories be conducted of both the irrigation potential and the agricultural drainage potential in the province.

From the work of the 1982 task force, a recommendation and terms of reference for the Agricultural Land Base Study were developed. Approval for the study was given by the deputy ministers of the departments with major interests in agricultural resource development. These departments were Alberta Agriculture; Alberta Forestry, Lands and Wildlife (formerly Energy and Natural Resources); Alberta Environment; Alberta Municipal Affairs and Alberta Transportation. Commitments of staff and other resources were given by them to undertake such a study, with direction to be given by a committee of assistant deputy ministers, the Agricultural Land Base Steering Committee.

In February, 1982, the Environment Council of Alberta was directed by order-in-council to conduct an enquiry into means for maintaining and expanding the Alberta agricultural land base and for maintaining its production. While bearing many similarities to the Agricultural Land

Base Study, the work of the Environment Council dealt with both the maintenance of the agricultural land base, including the protection of agricultural land from non-agricultural development and the conservation of soil resources, in addition to agricultural land base expansion and intensification.

Two concurrent natural resource management studies should be recognized as having a significant relationship to the Agricultural Land Base Study. The first is the South Saskatchewan River Basin Planning Program, undertaken by Alberta Environment, with public hearings conducted by the Alberta Water Resources Commission. This program has dealt with a broad range of issues involved with water management in the South Saskatchewan River Basin and much of the resulting factual information relating to irrigation development has been incorporated into the present study.

The second closely related report is the Drainage Potential in Alberta - An Integrated Study. This project has been carried out under the primary sponsorship of the Alberta Water Resources Commission and has been managed by an interdepartmental committee with representation from Alberta Agriculture, Alberta Environment and Alberta Forestry, Lands and Wildlife. It has been conducted in a manner compatible to the Agricultural Land Base Study, and has served as the source of the information on agricultural drainage used in the present study.

1.2 Objectives

The terms of reference for the Agricultural Land Base Study presented three broad provincial goals which provide the rationale for expanding and intensifying the use of provincial resources to increase agricultural production:

1) To increase the contribution of the renewable resource sector to the provincial economy;
2) To increase the rate of rural economic development; and
3) To decentralize economic development activity to all regions of the province.

Within the context of these provincial policies and goals, the following five objectives for the Agricultural Land Base Study were defined in the terms of reference:

1) To identify the natural resource management options available for the expansion and intensification of Alberta's agricultural land base;
2) To identify the geographic distribution and the maximum potential increase in agricultural production achievable through the application of the management options;
3) To assess the relative economics of the management options;
4) To evaluate the impact of such management options on other natural resource uses; and
5) To identify existing government programs that promote the application of the management options.

Five technical background reports present the information which was prepared and compiled for this study. These reports are:

1. Agricultural Land Base Study: Agricultural Inventory.
   A determination of the amount and location of the land in Alberta suitable for development under each of the identified options, and of the potential increase in agricultural production.
2. Agricultural Land Base Study: Economic and Financial Analysis: Direct Benefits and Costs.
   An analysis of the on-farm costs and returns associated with each of the options.
3. Agricultural Land Base Study: Analysis of Impacts on Other Resources.
   An identification of the impacts of agricultural development on other land and water resource users.
4. Agricultural Land Base Study: Economic Impact Analysis
   A summary from a societal perspective, of the direct and indirect benefits of each of the agricultural development options, their public investment requirements and the foregone benefits in other resource sectors.
5. Agricultural Land Base Study: Government Programs Promoting Agricultural Expansion and Intensification.
   A review of current government programs relevant to the objectives of the study.

All information in this Summary Report is drawn from the technical background reports and they should be consulted for details of methodology and references to publications and other information sources.

2. METHODS AND ASSUMPTIONS

2.1 Study Methods

2.1.1 Management Opportunities

The first objective of the Agricultural Land Base Study was to identify natural resource management opportunities available for the expansion and intensification of Alberta's agricultural land base. The terms of reference for the study identified the following 10 options for examination:

1. Green Area Conversion - conversion of arable land in the province's Green Area to cultivated crop production.
2. Irrigation Expansion - expansion of the irrigated land base in Southern Alberta using water supplies that can be developed within the South Saskatchewan River basin.
3. Drainage - drainage of non-permanent wetlands for crop production.
4. Deep Plowing - deep plowing of solonetzic soils.
5. Liming - liming of acid soils.
6. Summerfallow Reduction - reduction of summerfallow acreage.
7. Range Improvement - improvement of prairie range through breaking and reseeding and woodland range through clearing, breaking, seeding, fertilizing and fencing.
8. Prairie Range Conversion - conversion of prairie rangeland to annual crop production.
9. Woodland Conversion - conversion of woodland within current agricultural areas to annual crop production.
10. Saline Soil Reclamation - reclamation of dryland and irrigated salinized lands for crop production.

The provision of flood control on flood-prone lands adjacent to watercourses was also investigated. Because of the relatively small acreage affected and insufficient economic information, an analysis of this option was not completed. The Drainage option includes removal of excess moisture in areas not adjacent to watercourses.

The 10 opportunities listed above cover a wide range of opportunities for increasing agricultural production in Alberta, as well as achieving a number of other objectives. Three of the options, Green Area Conversion, Irrigation Expansion and Drainage, would require major public involvement in the provision of infrastructure if they were to be undertaken to their full potential. The other options are generally within the scope of individual land owners to undertake.

The potential for increasing agricultural production through the development of new technology, agricultural research, the increased use of fertilizers, improvements in farm management, the use of higher valued crops, and the role of livestock enterprises are not within the scope of the Agricultural Land Base Study.

2.1.2 Geographic Scope

The Agricultural Land Base Study was primarily restricted to the White Area (settled portion) of the province, shown in the Study Area map. The one exception was the Green Area Conversion option which included that portion of the Green Area classified by the Canada Land Inventory Soil Capability for Agriculture as being classes 1 through 4. For the Irrigation Expansion option the area considered was restricted to the South Saskatchewan River Basin and irrigation climatic zones A1 to C, as described in the South Saskatchewan River Basin Planning Program Summary Report. Excluded from the Agricultural Land Base Study were urban areas, areas zoned for rural residential, industrial, commercial or institutional use, national, provincial and municipal parks, wildlife

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STUDY AREA

EXCLUDED AREAS: Urban Areas, Indian Reserves (I.R.), National and Provincial Parks, Canadian Forces Bases, Country Residential (C.R.), and Industrial Commercial Zones (I.C.).

GREEN AREA: Public land currently not available for agricultural use other than grazing.

WHITE AREA: Predominantly potential agricultural land.

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sanctuaries, ecological reserves, military ranges and Indian Reserves. These excluded areas are shown in the Study Area map. The areas specifically identified for each option are described in Section 3.

2.1.3 Level of Detail

The Agricultural Land Base Study was conducted at a broad, reconaissance level of detail. The identification of the location of each of the options was conducted by using 1:1 000 000 scale maps, with the final maps produced at a 1:5 000 000 scale. Area estimates were estimated to the nearest 100 000 acres. The necessity of many assumptions in the economic analysis and elsewhere similarly limited the degree of accuracy that could be achieved. The purpose of this "broad brush" approach was to develop a perspective of the order of magnitude of the physical possibilities and their relative economic benefits and impacts on other resource users. It was emphasized throughout the study that the results were too generalized to be useful for specific resource allocation decisions.

2.1.4 Marginal Analysis

Marginal or incremental analysis was used throughout this study. Only those costs, benefits and impacts which would be created by the proposed options were taken into consideration. This marginal approach was applied to both the dollar values used in the economic analysis and the physical or non-economic impacts, identified in other parts of the study, such as the effects of development on resource sustainability.

2.1.5 Economic and Financial Analyses

Both economic and financial analyses were employed in this study. The economic analysis results show the feasibility of the various management opportunities from the provincial economy's, or provincial society's, point of view. The first major characteristic of the economic analysis was that it excluded all transfer payments within the

province, such as subsidies, taxes and interest payments. These do not make the province as a whole better or worse off and therefore do not affect the feasibility of a management option from an economic point of view.

The second major characteristic of the economic analysis was that it took into account all off-farm economic costs and benefits, such as public infrastructure requirements and foregone economic benefits in other resource sectors. These directly affect the feasibility of an option from a societal perspective.

The financial analysis results show feasibility from the point of view of profitability to the farmer. This analysis took into account all cash flow considerations, including subsidies, taxes and interest payments. It excluded all off-farm costs and benefits, although an indication was made of those off-farm costs which farmers are currently required to share.

2.1.6 Agricultural Production Estimates

In order to determine the agricultural production potential of the various development opportunities information was collected on average yields, yield increases due to the investment or management change, cropping pattern and the potential acreage available for improvement. This information was collected on the basis of the major soil zones in the province. These soil zones form a basis for viewing the regional effects of the development options, and are closely related to agricultural productivity through such factors as growing season, precipitation and soil organic matter. The six soil zones which were defined for this study were: Brown, Dark Brown, Black, Gray - Central Area, Gray - Peace River Area, and Gray - Green Area. These are shown in the Soil Zones map.

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AGRICULTURAL LAND BASE STUDY

SOIL ZONES

ADAPTED FROM ALBERTA INSTITUTE OF PEDOLOGY SOIL GROUP MAP OF ALBERTA

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Benchmark yields were defined for each soil zone and for each of five major crops: wheat, oats, barley, canola and hay. Increased crop yield for each development option were referenced to these established benchmarks. Some options bring reduced yields up to benchmark levels (e.g. Deep Plowing), while others raise yields above the benchmark level (e.g. Irrigation Expansion). Representative farm sizes and crop mixes were determined for the various development options according to soil zones. These formed the basis of farm production cost estimates used in the economic and financial analyses.

2.1.7 Risk and Uncertainty

The Agricultural Land Base Study did not attempt to resolve or accurately document all areas of risk and uncertainty, but dealt with uncertainty through sensitivity analyses. These analyses, conducted in the on-farm portion of the study, simply vary individual factors such as discount rates, costs, prices and yields. The results give an indication of the variability or sensitivity of the final indications of feasibility. Options were identified where a small margin of feasibility exists or where the sensitivity analysis indicates that development may not be economically feasible. The degree of risk associated with the various options may itself be a useful criterion for judging their relative attractiveness to society or to the farmer.

2.1.8 Provincial Economic Growth

Benefit cost analysis typically examines economic efficiency by comparing total direct benefits and costs. The results of this analysis are presented under the headings of Direct Net Benefits. A second economic analysis was conducted to document growth in the provincial economy. The analysis of Growth in the Provincial Economy indicates direct and secondary value added from increased agricultural output and investment, less the corresponding losses in forestry, hunting and trapping. Its results are presented under the heading of Value Added Results. This analysis treats all gains in value added, or income, as benefits and all losses in value added as costs.

One of the main differences between the Direct Net Benefit analysis and the Value Added analysis is that the former treated the full amount of investment requirements as a costs, while the latter treated the value added, or income generated, by investment as a benefit. The second main difference between the two analyses was that the Value Added analysis included an estimate of secondary benefits resulting from both agricultural production and investment activities. These secondary benefits would be created if there were unemployed and mobile resources in or available to the Alberta economy. The value-added analysis includes the following components:

1. Value added from agricultural production, equal to on-farm gross revenue less on-farm operating costs.
2. Value added from public and private investment, also equal to gross revenue for construction and similar firms, less their operating costs.
3. Secondary or spin-off value added throughout the provincial economy, resulting from both increased agricultural production and investment.

Each of these three components are treated as benefits in the value added analysis. From these are deducted the following categories of lost value added:

1. Lost value added in the forestry, wildlife (hunting and trapping) and grazing sectors.
2. Secondary value added associated with forestry, wildlife and grazing.

Because of the lack of information regarding future resource unemployment and mobility, this study adopted a conservative approach to secondary benefit estimation. The multipliers which were used took into account only the "backward linkages" through input suppliers. They also excluded spending through the household sector and included "leakages" of expenditures for imports to the province. Among the 10 development options, secondary benefits account for an average of less than 25 per cent of the total value added.

The Value Added analysis, therefore, counted benefits, or economic growth, in both the agricultural sector and elsewhere in the provincial economy, and deducted foregone benefits. The benefits outside the agricultural sector would accrue to construction firms, input suppliers, and other firms, largely in the region in which the resource development would take place. The Direct Net Benefit analysis counted only agricultural benefits, and deducted foregone benefits and the full public and private investment costs.

2.1.9 Forestry Benefits Lost

In general, the impacts of agricultural development on timber resources, wildlife and rangeland were determined by overlaying maps of development areas with those of the resource use in question to determine the areas affected. Lost forestry benefits foregone were determined on the basis of the value of the underutilized timber growing stock volume and incremental growth, during clearing. The loss of future production from the time of clearing was also measured. The gross value of timber production was calculated by forest area and species and standard stumpage values (returns to forest and mill operations) were applied. These stumpage values varied according to species and end product. Net values were derived from the difference between gross values and all costs (production and capital).

2.1.10 Wildlife Benefits Lost

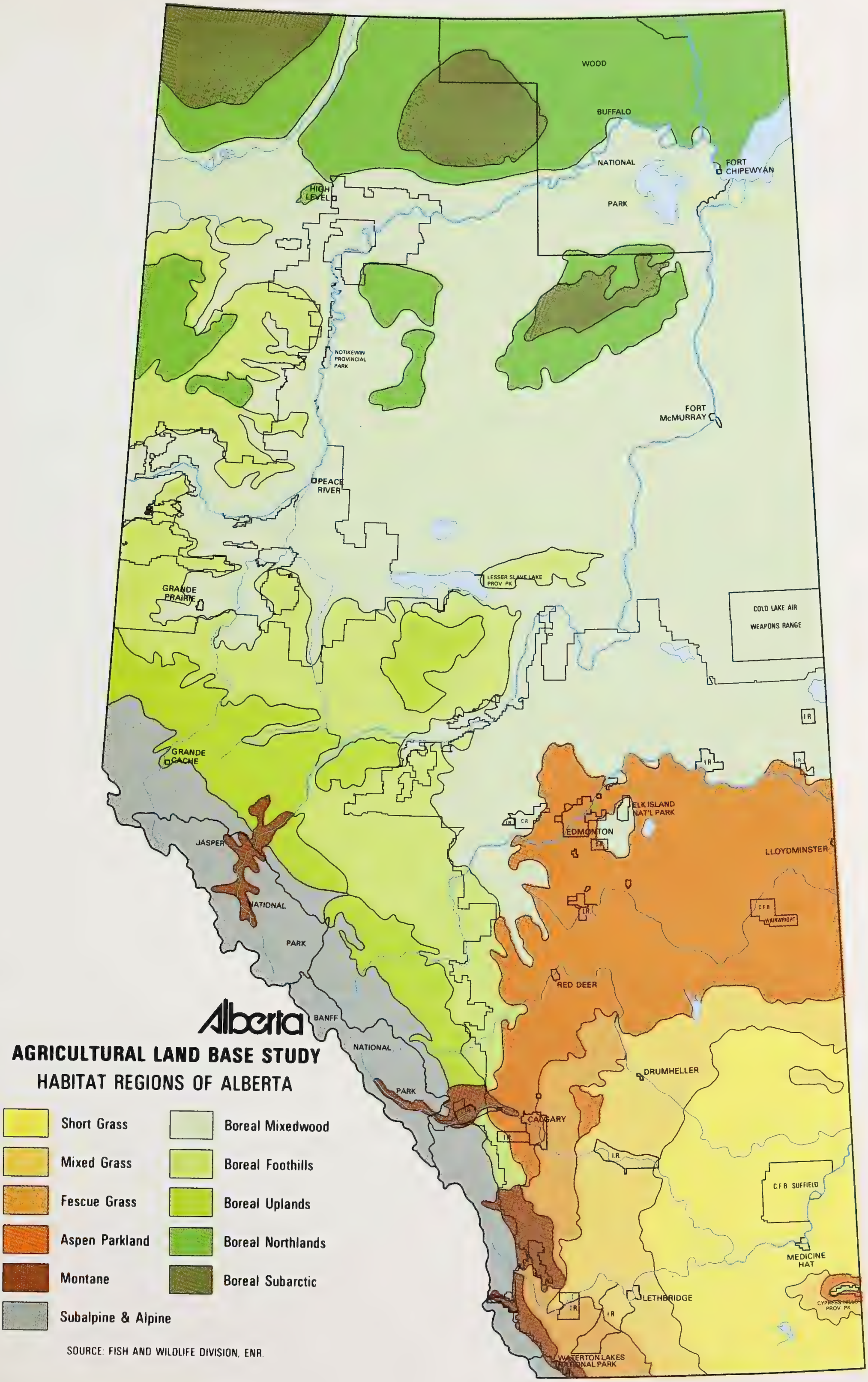
An assessment of the impacts of the various development options on Alberta's wildlife resources was made by determining the effect of the options on non-agricultural land base. The habitat areas which were used in this analysis are shown in the Habitat Regions of Alberta map. A number of wildlife species were selected for study because of their economic importance. The estimated losses in wildlife numbers, resulting from habitat disruption, were expressed as a percentage of the total population. These losses were assumed to result in an equal reduction in hunting days, although this would not cause a change in the value of such

a day. Rather than placing a value on individual species, estimates of willingness-to-pay (the stated value of hunting days over and above actual expenditures, derived from surveys) and the reduction in the average annual number of days of hunting were used to value the loss in wildlife. Commercial use of wildlife was also estimated in terms of the impact of changes in wildlife numbers on trapping revenues.

In determining the impacts on wildlife, only the following selected species were considered; moose, elk, mule and white-tailed deer, antelope and black bear. Impacts on waterfowl and upland bird game were included for only the Drainage option. The exact magnitude of the impact of agricultural expansion and intensification on the province's valuable sport and commercial fisheries is unknown but it is expected to be minimal for most options. It is certain, however, that in the long run there will be a decline in benefits. In addition, only certain kinds of activities (recreational hunting and trapping) were included. In the light of this, the estimated losses in wildlife benefits would only be a small fraction of the actual reduction in benefits if the overall ecosystem effects are taken into account. Furthermore, real fish and wildlife values may not remain constant. If the quantity of available wildlife resources shrinks, the future value of these resources may be even higher.

2.1.11 Resource Conservation

Although the development of resources for agricultural production may create impacts or costs for other resource uses, steps can be taken to offset or mitigate some of these negative consequences. Development opportunities such as Green Area Conversion, Woodland Conversion and Prairie Range Conversion could lead to increased soil erosion unless adequate soil conservation measures were taken. Similarly, Drainage would have to be designed to prevent downstream flooding and erosion, and some reduction in habitat losses could also be achieved through appropriate drainage designs.



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Mitigation of the impacts of agricultural development on soil and water resources is generally possible and would be encouraged by government policy. It was not within the scope of this study, however, to investigate the costs and effectiveness of the various private and public mitigation and conservation measures which could be undertaken. The study identified the general mitigation and conservation requirements to sustain the resource.

Some impacts of agricultural development could not be mitigated. Timber production losses due to Green Area Conversion cannot be reduced. Wildlife habitat losses associated with Green Area Conversion, Prairie Range Improvement, Prairie Range Conversion and Woodland Conversion, and resulting from the improvement of currently unimproved lands, could not be practically or economically offset. Massive amounts of funds would be required for the enhancement of remaining low value habitat and for the purchase and enhancement of additional lands that will be required for wildlife habitat.

2.2 Major Assumptions

Because the Agricultural Land Base Study was conducted at a broad reconnaissance level of detail, it was necessary to employ a number of assumptions to complete the study. Many of these are key to understanding and interpreting the study results. Further assumptions specific to individual development opportunities are described in Section 3.

2.2.1 Development Location

The Canada Land Inventory Soil Capability for Agriculture was used to define lands with agricultural development potential for several of the development opportunities in this study. Lands identified as CLI class 1 to 4 were assumed to be arable and suitable for cultivated crop production, while CLI class 5 land was assumed to be most suitable for improved pasture and forage production. Arable lands which are currently unimproved were assumed to be suitable to conversion to cultivated crop production. Those with acid, solonetzic or saline soils were identified for treatment of those limitations.

2.2.2 Average Yields and Prices

It was assumed that markets would be available for all increased output from agricultural development. Ten-year average prices (1973 to 1982) expressed in 1982 dollars and 1982 costs of production were used in the economic analysis. Market-related factors of demand and price were not to be considered a constraint to agricultural development.

Ten-year average yields (1973 to 1982) for the major crops were also used. Averaging over this period satisfactorily removed the effect of year to year fluctuations due to changes in weather and other factors. It does not reflect the long-run improvement in yields which has been achieved in the past due to new crop varieties, other new technology and better farm management. However, these factors were explicitly excluded from the scope of the study.

2.2.3 Cost of Capital

The economic and financial analyses employed discounting to bring costs and benefits from different years to a present value for comparison. A five per cent real discount rate was used in this study. The real discount rate is the difference between the interest rate which is charged to borrowers and the rate of inflation. A discount rate of approximately five to seven per cent has been common in other public project analyses in Alberta. It also relates to conditions at the beginning of the study when nominal interest rates were 12 to 14 per cent and inflation was seven to nine per cent. The farm financial analysis of each of the options included additional financing costs at a 13 per cent rate. It was assumed that all on-farm investment was based on borrowed capital. Sensitivity analyses were conducted during the on-farm analysis. These included the use of three and seven per cent discount rates.

2.2.4 Maximum Development

It was assumed that each of the options would be undertaken to its full potential extent. Since expansion areas are not homogeneous in their soils, climate and other characteristics, different levels of development would have different impacts and economic results. This means that partial or limited development could be more attractive economically or could have lower impacts on other resource users if it were undertaken in carefully selected areas. Economic and financial results, presented on a per acre basis, give an indication of the results of partial development. Drainage results reported here are based on the drainage of non-permanent wetlands only. A full drainage case is described in the Inventory of Alberta's Drainage Requirements.

2.2.5 Standard Phase-In Periods

It was not possible to make a detailed evaluation of the likely rate of implementation of each of the options. It was assumed in the economic analyses, for simplicity, that development of those options which involve large public investment would require 100 years. These include Green Area Conversion, Irrigation Expansion and Drainage. It was assumed that all other options could be implemented over 50 years. The period of analysis of costs and benefits following implementation for each of the options was infinite. There was periodic reinvestment in some options where necessary.

2.2.6 Current Productivity in Other Resource Sectors

The impacts of agricultural development on other resource sectors were evaluated in terms of the current management practices and level of productivity in those sectors. The only exception to this assumption was in the assessment of foregone timber production benefits. The assumed rate of timber harvest was above the recently achieved rate of harvest.

3. STUDY RESULTS

3.1 Green Area Conversion

3.1.1 General Description

The Green Area consists of public lands withdrawn from settlement, and covers approximately half of Alberta's total area. This land is managed primarily for forest production, watershed protection, recreation and other multiple uses. Agricultural uses, other than unimproved grazing, have been restricted. Suitable public lands are periodically withdrawn for agricultural development, with the actual amount of new land withdrawn for agriculture in recent years averaging approximately 20 000 acres annually. Most of this development and expansion occurs along the existing Green Area boundry and is primarily located in the Peace River district. Northwest Alberta is considered to be one of Canada's last remaining tracts of land with a physical potential for agricultural expansion.

3.1.2 Agricultural Inventory

Expansion of agricultural production onto land not currently allocated to agriculture involves clearing, piling and burning of the brush cover and, in some cases, commercial harvesting of suitable timber, as well as breaking and working down of the land in preparation for seeding. Canada Land Inventory (CLI) agricultural capability Class 1 to 4 lands are considered suitable for annual field crop production.

Approximately 10.8 million acres of CLI Class 1 to 4 lands are located in the province's Green Area. The Public Lands Division, Alberta Forestry, Lands and Wildlife, estimates that 15 per cent of the land classed as CLI 1 to 4 is unsuitable for cultivation due to various

physical landscape limitations. Therefore, 9.2 million acres of these lands were considered suitable for agricultural expansion in this study. The Potentially Arable Land in the Green Area map shows the distribution of land suitable for conversion.

Ninety per cent of the lands available for conversion are CLI Class 4 with severe limitations which restrict the range of crops or require special conservation practices. Average Peace River crop yields were therefore reduced by 20 per cent in estimating the productivity of the lands for this option. Production estimates were based on the same representative crop mix (including wheat) as in the Peace River area.

Assuming all of the 9.2 million acres were developed for crop production, the estimated annual increase in the annual gross value of production would total $763 million (Table 3.1.1). There would be an annual reduction in unimproved grazing of approximately 22 600 animal unit months (AUMs) with a value of $1.04 million, resulting in a net increase in annual production of $762 million.

3.1.3 Impacts On Other Resource Users

The conversion of 9.2 million acres for agricultural crop production would have major impacts on wildlife and timber production. Unimproved grazing, recreation and soil and water resources could also be affected. Agricultural conversion would reduce the total Green Area acreage by approximately 10 per cent, most of it in the northwest or Peace River region of the province.

Agricultural conversion would reduce wildlife resources through the loss of habitat. Approximately 18 per cent of the Green Area lands in the Department of Forestry, Lands and Wildlife's Peace River administrative region would be taken up by agricultural conversion. The Boreal Mixedwood and Boreal Foothills would be the two habitat regions most

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POTENTIALLY ARABLE LAND IN THE GREEN AREA

CLI 1-4 Land in the Green Area

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Table 3.1.1

GREEN AREA CONVERSION, AGRICULTURAL CROP PRODUCTION

	Crop Yield	Crop Mix	Area	Production	Gross Value Of Production
	(bu./ac.)	(%)	(mill. ac.)	(mill. bu.)	($ mill./yr.)
Wheat	23.5	18	1.66	39.0	195.8
Oats	43.9	4	.37	16.2	27.9
Barley	30.3	30	2.76	83.6	234.2
Canola	13.0	12	1.10	14.3	112.4
Hay	1.5[1]	16	1.47	2.4[2]	192.9
Summerfallow	---	20	1.84	---	----
Total	---	100	9.20	---	763.2

1. tons/acre.
2. millions of tons.

severely affected. Most of the resident mammal and many of the resident breeding bird species would be reduced to some degree by agricultural conversion. The potential reduction in the province's capability to produce selected major wildlife species is as follows: moose (-23 per cent), elk (-6 per cent), white-tailed deer (+8 per cent) and mule deer (-6 per cent). Species especially vulnerable to human activities, such as grizzly bear and caribou, would have their range considerably reduced as approximately 65 per cent of their habitat would be affected.

Agricultural conversion would significantly reduce both the consumptive and non-consumptive use of wildlife resources in the Peace River administrative region. It would become more difficult to hunt or view species since these populations would be forced to shift to less productive and more isolated habitats. Trappers, guides, natives and other individuals who make their living from, or subsist on the wildlife resource may have to adjust their lifestyles accordingly.

Conversion would affect approximately 10 per cent of Alberta's total coniferous Annual Allowable Cut (AAC), while the total deciduous AAC would be reduced by about 24 per cent. The loss to committed coniferous and deciduous AAC (amounts given to specific quota holders) would be slightly larger, 15 and 31 per cent respectively. Losses for committed coniferous AAC would range from two per cent in the Rocky Forest to as high as 24 per cent for the Slave Lake and Whitecourt Forests. The loss of committed deciduous AAC would range from nine per cent in the Rocky and Edson Forests to a high of about 46 per cent in the Grande Prairie Forest. Selected forest management agreements would also be severely affected as Canadian Forest Products Limited could lose approximately one-third and one-half of their coniferous and deciduous AAC respectively. The effects of would be high on all forest management areas except the Proctor and Gamble provisional reserve. In most cases the proportion of land lost would be less than the volume of timber lost relative to provincial totals indicating that the lands identified for conversion have higher than average productivity.

Approximately 20 500 animal unit months (AUMs) of unimproved grazing capacity would be lost to crop production. A major reduction, about 9 100 AUMs, would occur in the Grande Prairie Forest. The Grande Prairie, Peace River, Slave Lake and Whitecourt Forests would each lose over one-third of the grazing provided at present for local farmers. This loss represents approximately 17 per cent of grazing activity in the Green Area. However, this loss represents less than one per cent of the total provincial grazing activity on public lands.

The impact of agricultural conversion on existing Alberta Forest Service recreation sites is difficult to assess at this scale. However, reduced aesthetic values, lower water quality and the loss of lands for dispersed recreational activities could reduce the quality of the recreation resource.

Conservation and mitigation measures must be implemented as part of any agricultural development initiative. The absence of these measures would greatly reduce the quality of soil and water resources in north-

western Alberta. Land clearing and drainage could increase surface runoff and reduce storage capacity resulting in a higher potential for flooding as well as extreme low flows. Effective soil conservation practices would need to be employed as sensitive soils are exposed by clearing and cultivation. Without such conservation measures, erosion would produce increased sediment and nutrient loading in water-courses and gradual water quality deterioration related to eutrophication and turbidity.

A significant impact from agricultural development would be its effect on population distribution and regional economic development. The financial analysis indicates that a homesteader could not rely solely on farming income. The requirement for off-farm income could affect the success of farm operations given that less time and energy would be directed to farm maintenance and improvement. Overall, the unique financial hardships facing these possible farmers could lead to greater farm turnover compared to other regions of the province. Care must be taken to ensure that a segment of the population would not be stranded in marginal operations. This may require that additional programs (e.g., regional economic development) and precautions (e.g. ensuring high farm management skill) be undertaken to prevent social problems.

3.1.4 Farm Financial Effects

An analysis of financial feasibility, was designed to indicate the profitability of establishing farm units on previously undeveloped land. Several types of support payments available to beginning farmers, and the corresponding costs, were included. These included a land development grant, grain stabilization payments and premiums, and crop insurance payments and premiums, as well as land purchase costs. The analysis was conducted both with and without financing costs (payments to the Alberta Agricultural Development Corporation or other financial institutions) and taxes and with both zero and 30 per cent equity levels.

It was assumed that for a one section (640 acre) farm, 485 acres or 75 per cent of the area could be cultivated and that this development would take six years. For a two section (1 280 acre) farm it was assumed that 960 acres could be developed in seven years. The land development costs were estimated to be an average of $230 per acre.

The results are given in terms of annual equivalent (or annual average) cash flow. They show the returns to labor and management, calculated with a five per cent discount rate. Financing charges are included in the after financing section at an interest rate to 13 per cent. The residual value of land and equipment at the end of the 30-year project life are also included in the financial analysis (Table 3.1.2.)

Table 3.1.2

GREEN AREA CONVERSION, ANNUAL AVERAGE FARM FINANCIAL RETURNS

	Average Annual Cash Flow		
	Total Resources	After Financing	After Fin. and Tax
		($/acre)	
960-Acre Farm			
Zero Equity	$15.99	-$17.50	-$17.62
30% Farmer Equity	--	-0.20	-1.03
485-Acre Farm			
Zero Equity	11.84	-26.29	-26.42
30% Farmer Equity	--	-13.50	-13.54

Conversion is financially feasible only at the total resource level; that is, when 100 per cent equity is assumed and no return to farmer equity is provided for. When the costs of borrowed capital are included, the option appears to be not financially feasible. The case in which 30 per cent equity and no return to that equity is assumed appears to be marginally feasible.

Green Area Conversion would be expensive. Clearing and farming new lands requires good management skills. Soils would need to be managed carefully in order to sustain a viable farm unit. Since only the 960-acre farm size and 30 per cent equity level showed marginal financial feasibility after financing charges were included, several factors would be required to make this venture successful. Farmers would need to bring significant equity into the venture and be prepared to support the farm over many years with off-farm employment. Off-farm employment would have significant implications on economic planning for Northern Alberta. The possibility of over 9 000 new farms being established would result in large employment requirements in the forestry and oil and gas sectors.

Even with good management and off-farm support, there would be significant risks associated with climate (yields) and financial conditions (interest rates, costs and prices). Successful establishment of farms would depend on a detailed identification of locations with soils of better than average productivity and more favorable climate. It would also depend on favorable markets for products.

3.1.5 Provincial Economic Effects

The provincial economic analysis incorporated both public investment requirements and benefits lost to other sectors as costs of agricultural development. However, the analysis did not consider the farmer's transfer payments since these do not affect the feasibility of any of the options for the province as a whole. It was assumed that the 9.2 million acres would be phased in over 100 years at a rate of 92 000 acres a year. With phasing-in, the gross value of agricultural production was estimated to be $3 273 million. The value of on-farm and public investment costs was $1 515 million and $989 million, respectively, leaving a net value of $769 million.

The gross value of production estimates were based on the productivity generated by 9 000 two-section farms, as adapted from the on-farm financial analysis. The on-farm investment costs include land development, equipment, and the farmer's share of utilities. The costs

of public investment were estimated on the basis of existing investment in the Peace River region, and included surveys, roads, drainage, power, schools, hospitals and other community infrastructure. Costs would depend on the design of the development and the degree of servicing, e.g., road access. The need for schools, hospitals and recreational facilities would depend on proximity to existing centres and on how full these centres are.

It was assumed that the level of drainage and accompanying public investment costs would be equal to that of currently developed lands in the Peace River region. It is less intensive than that investigated under the Drainage option in this study (Section 3.3). Public investment costs for drainage were estimated at $162 per cultivated acre, with an additional $9 annual maintenance cost per cultivated acre. The cost for drainage is estimated to be $273 million plus an additional $258 million for maintenance; totalling $531 million.

Timber production benefits lost were determined as the value of the underutilized growing stock and incremental growth during clearing, as well as the loss of future production. Net or stumpage values were also calculated as the difference between timber product values and the cost of production. As with agricultural values, the timber production values were estimated on the basis of a 100-year phase-in period. The gross value of timber production was calculated by forest area and species. It is assumed that 50 per cent of coniferous and 40 per cent of deciduous volumes would be harvested for use during agricultural conversion. Based on these procedures, the gross timber revenue lost was estimated at $10.2 billion and the net value at $1 billion. These figures were based on an Alberta Forest Service estimate that 5.7 million acres of currently or potentially productive forest lands would be affected within the 9.2 million acres.

In addition to the lost timber revenue, cultivation would also reduce forest grazing dispositions. The Alberta Forest Service estimates that approximately 20 500 AUMs will be lost on approximately 88 000 acres. Over a 100-year development period this is equivalent to a loss

of 881 acres and 205 AUMs of grazing per year. At a value of $47 per AUM, the gross value of the lost grazing resource would be $3.8 million and the corresponding net value would be $1.1 million.

The value of the lost hunting benefits based on willingness to pay, was estimated to be $14.3 million. In addition, a net value of approximately $2 million, would be lost from displaced trapping.

Table 3.1.3 shows the agricultural benefits, investment costs and lost benefits presented above. The value added, or gross margin, for agriculture is equal to gross revenue minus operating costs. The net on-farm benefit is equal to the gross margin less the on-farm investment costs. Lost timber, grazing and trapping benefits are also calculated as net benefits (gross revenue less operating costs and investment costs).

Table 3.1.3

GREEN AREA CONVERSION, DIRECT NET BENEFITS

		Benefits	Costs	Net Benefit
		($ million, present value)		
Agricultural Value Added		1 758		
Investment Cost:	on-farm		989	
	off-farm		531	
Lost Benefits:	timber and grazing		1 038	
	hunting and trapping		16	
Total		1 758	2 574	-816

The direct benefits and costs, including lost benefits were based on sustained yields in each sector and reflect the total direct gains and losses associated with agricultural development. The direct net present value of -$816 million is a return to land, labor and

management. Its negative value indicates that the direct benefits from increased agricultural production are less than the total investment costs plus other sectors lost benefits. On a per acre basis, this is equivalent to -$89.

The impact of Green Area Conversion on the provincial economy is measured by the increase in direct value added to the agricultural and construction sectors, less losses to the forestry and wildlife sectors. Timber, grazing and trapping losses equal gross revenue less operating costs. Lost hunting benefits are equal to the hunter's willingness to pay plus those losses associated with reduced hunting expenditures. The secondary or spin-off effects of these changes in value added were also estimated as possible impacts on the economy (Table 3.1.4).

Table 3.1.4

GREEN AREA CONVERSION, VALUE ADDED RESULTS

	Direct Value Added	Secondary Value Added	Total Value Added
	($ million, present value)		
Benefits Gained			
Agriculture	1 758	610	2 368
Public and Private Investment	772	282	1 054
Total Benefits Gained	2 530	892	3 422
Benefits Foregone			
Timber and Grazing	2 725	2 601	5 326
Hunting and Trapping	31	5	36
Total Benefits Foregone	2 756	2 606	5 363
Total Net Benefits	-226	-1 714	-1 941

The increase in direct value added (gross revenue less operating costs) resulting from agricultural development would be $1 758 million. There would also be an increase in economic activity in other sectors as a result of land development, equipment purchase and investment in

infrastructure (roads, utilities, etc.), totalling $772 million. The total increase in direct provincial value added would therefore be $2 530 million. If secondary benefits are included, total benefits from agricultural expansion would be $3 422 million.

Direct benefits lost to the forestry, wildlife and grazing sectors totalled $2 756 million. The $31 million lost benefit in the hunting and trapping sector included both lost willingness to pay and lost value added from trapping and hunting expenditure. The total net benefits from this option would therefore be -$1 941 million, or -$211 per acre.

3.1.6 Summary of Green Area Conversion Results

Potential Scale

Potential Acreage for Development	9.2 million acres
Annual Agricultural Production Potential	$762 million ($83 per acre)

Annual Farm Financial Returns

(960 acre farm, zero equity)	-$18 per acre

Economic Results (Present Value)

Gross Revenue	$3 273 million
less operating costs	1 515
On-Farm Value Added	$1 758
less on-farm investment costs	989
On-Farm Net Benefit	$ 769
less public investment costs	531
lost net timber benefits	1 037
lost grazing benefits	1
lost hunting and trapping benefits	16
Net Direct Benefits	-$ 816 million (-$89 per acre)

Growth in Provincial Economy (Present Value)

Direct Net Value Added	-$ 226 million
Secondary Net Value Added	-$1 714
Total Value Added	-$1 941 million (-$211 per acre)

Potential Significant Impacts:

Negative: Timber, Wildlife, Grazing, Soil Conservation, Water Resources

Positive: Transportation and Utility Infrastructure Benefiting Other Sectors

3.2 Irrigation Expansion

3.2.1 General Description

Most of the province's irrigated lands are located in the semi-arid regions of Southern and South-central Alberta. Lower precipitation and higher evaporation rates combine to severely limit crop growth in much of this region. Higher value crops can be grown and productivity can be increased by 60-200 per cent with irrigation. The amount of land actually irrigated yearly varies in relation to the frequency of natural precipitation. The historical rate of increase in the acreage serviced by the 13 Irrigation Districts is over 30 000 acres per year. However, the limited volume of water available for irrigation restricts the total area which can be irrigated. Irrigation currently protects over a million acres of fertile land from drought-related crop failure.

Seven per cent of all farms in the province are irrigated, although over 68 per cent of the farms in the Lethbridge area are irrigated. In most of Southern Alberta the average irrigated area per farm is over 200 acres. The 1981 Census of Agriculture reported average farm sales of $232 per irrigated acre and $93 per non-irrigated acre. It also reported close to twice the level of assets and 70 per cent of the improved land area in irrigation farms relative to dryland farms.

In addition to the potential in Southern Alberta, there are opportunities for small supplemental irrigation projects in most of the agricultural area. The location of such projects will be influenced by soil characteristics, local climate and water supply and cropping intentions.

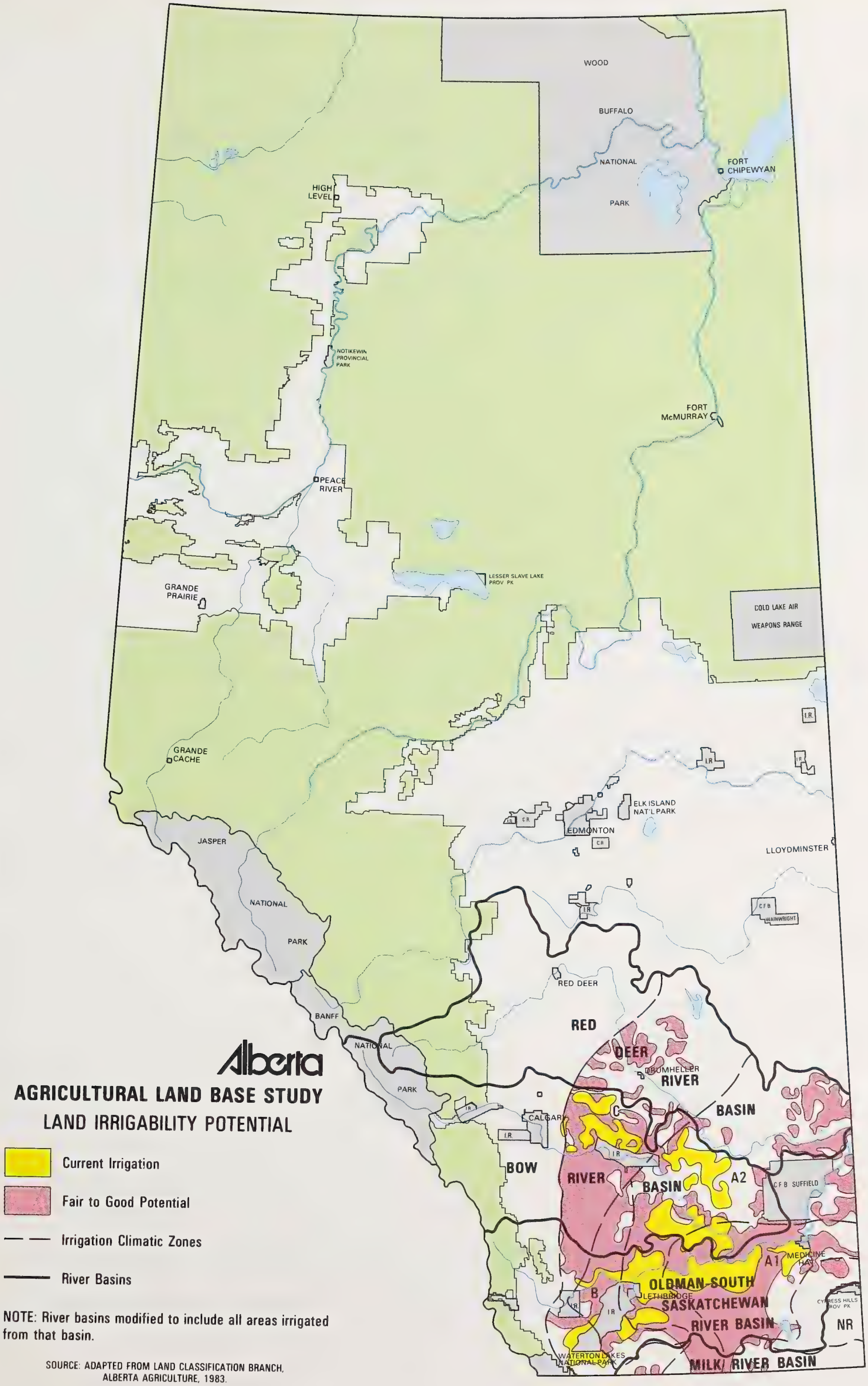
3.2.2 Agricultural Inventory

Not all lands are suitable for irrigation. Lands with fair to good potential for irrigation must have good water holding capacity and a suitable water intake rate. They must also have good profile development, texture, drainage, low sodium content and level to slightly undulating relief. Within the area defined by the Irrigation Climatic Zone C boundary, shown in the Land Irrigability Potential map, there are approximately 8.9 million acres with fair to good irrigation potential. Despite the large amount of irrigable land, the absolute potential is limited by the available water supply in the South Saskatchewan River Basin. The maximum acreage which could be irrigated in Southern Alberta is 2.3 million acres. This assumes full development of storage and delivery systems, fulfilment of an interprovincial agreement to pass approximately 50 per cent of the natural flow from the basin to Saskatchewan, and no interbasin transfer of water into the basin. This area estimate includes the currently irrigated acreage of 1.2 million acres; approximately 1.1 million acres within organized irrigation districts and 0.1 million acres under private projects. Thus the maximum potential for irrigation expansion, given available water supplies, is an additional 1.1 million acres (Table 3.2.1). The irrigation climatic zones referred to in the table are illustrated in the Land Irrigability Potential map.

Table 3.2.1

IRRIGATION EXPANSION, IRRIGATION POTENTIAL AND LANDS CURRENTLY SERVICED FOR IRRIGATION

Irrigation Climatic Zones	Land with Fair to Good Physical Capability	Maximum Irrigation Acreage	Currently Irrigated Lands	Maximum Irrigated Expansion
		(thousands of acres)		
A1	2 589	679	397	282
A2	3 398	1 272	650	622
B	916	102	72	30
C	1 904	286	84	202
Total	8 896	2 339	1 203	1 136



PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA ENERGY AND NATURAL RESOURCES, 1985.

Servicing such an area would involve the construction of storage reservoirs, many new canals and other local water distribution and control works, some of which are included under existing provincial commitments.

Crop yields under irrigation are typically much higher than dryland yields. Productivity increases from irrigated lands range from 60-200 per cent. Also, higher valued crops and a wider range of crops may be grown with irrigation. Approximately 35 different crops are grown on irrigated lands in southern Alberta. For this study, production estimates were restricted to the five major crops since these account for over 80 per cent of the irrigated acreage. Table 3.2.2 shows the comparative Brown and Dark Brown soil zone dryland benchmark yields and crop mix and Table 3.2.3 shows the corresponding irrigated crop yields and crop mix used in this analysis. Production estimates are based on the incremental increases beyond the current dryland production potential. The crop mix used for the economic analysis varied by irrigation climatic zone.

Table 3.2.2

IRRIGATION EXPANSION, DRYLAND CROP YIELDS AND CROP MIX

	Brown[1] Soil Zone	Crop Mix	Dark[2] Brown Soil Zone	Crop Mix
	(bushels/acre)	(%)	(bushels/acre)	(%)
Wheat	26.4	42	32.7	37
Oats	41.6	2	60.1	3
Barley	44.1	6	50.9	17
Canola	18.0	.5	24.3	4
Tame Hay (Tons/acre)	0.6	7	1.0	7
Summerfallow	-	41	-	29

1. Brown soil zone - Irrigation climatic zones A1 and A2.

2. Dark Brown soil zone - Irrigation climatic zones B and C.

Table 3.2.3.

IRRIGATION EXPANSION, IRRIGATED CROP YIELDS AND CROP MIX

	Irrigation Climatic Zone				
	A1	A2	B	C	Crop Mix
	(bushels/acre)				(%)
Wheat	86.3	85.8	89.4	80.3	54
Oats	95.9	95.7	96.7	94.8	2
Barley	95.9	95.7	96.7	94.8	17
Canola	46.1	47.9	47.9	48.2	1
Tame Hay (tons/ac.)	3.1	3.1	3.0	2.8	26

The estimated annual increase in gross value of agricultural production totals is $306.5 million.

3.2.3 Impacts On Other Resource Users

The identification of impacts on other resource users was undertaken without knowing which land would be developed. If unimproved land were used for irrigation expansion, the impacts on wildlife would be high, as described below. The actual impact of irrigation development on wildlife species would, however, be expected to be much less than this "worse case" scenario because it is likely to be directed towards improved dryland farming areas.

Irrigation expansion could reduce the non-agricultural lands in the Department of Forestry, Lands and Wildlife's Southern and Central Administration regions by 16 and four per cent respectively. Irrigation could severely affect the Shortgrass Prairie habitat region. Irrigation is largely a negative influence on most wildlife species as irrigation farming practices are more intensive than dryland practices. Most resident mammal and breeding bird species could be harmed. The estimated

reduction in the province's capability to produce selected major wildlife species could be as follows: antelope (-18 per cent) white-tailed deer (- one per cent) and mule deer (- three per cent). Many other species could show similar declines. However, if the margins of newly irrigated fields are left in an undeveloped state then a number of species could benefit from the increased forage production. Further, the canal system and off-stream storage facilities may also produce new habitat for a variety of wildlife species.

Fish habitat may be enhanced in areas where streamflows are regulated as a result of on-stream storage works. Where stream flows are lowered or made more variable, fish habitat will decline. Increased temperature and low dissolved oxygen would reduce the quality of fish habitat, and the presence of algae and pathogens would limit recreational uses. The most severe impacts would occur in the lower Red Deer, Bow and Oldman Rivers.

The expansion of irrigated acreage would also produce benefits for other water users. At present there are 48 municipalities in Southern Alberta servicing approximately 21 000 people, with water drawn from the irrigation system. There are also 13 industrial water users which rely on the irrigation system for their supply. Furthermore, there are about 50 developed recreation sites located on irrigation reservoirs. These sites provide a range of recreational services to the local population and others.

The potential exists for some lands to become salinized if irrigated. Careful land classification and the adoption of modern system construction and farm operation procedures should minimize this problem.

3.2.4 Farm Financial Effects

A combination of two types of farm-level irrigation development was investigated. The first, intensification and extension of the irrigation system within or adjacent to irrigation districts, was assumed to take

place over 10 years. This time would be required to undertake on-farm investment in equipment and other management changes. The second type of development, the expansion of irrigation to new blocks of land, was assumed to take place over 20 years to allow for the development of irrigation expertise among dryland farmers.

The analysis was conducted on the basis of 10 000-acre blocks. The annual production cost estimates used in the financial and economic analyses were essentially the same as those used in the South Saskatchewan River Basin Planning Program (Alberta Environment), making the analysis comparable with those of the former study. Both the financial and economic analyses were incremental analyses showing the results of a change from dryland to irrigated production, rather than the irrigation costs and returns alone. Table 3.2.4 shows the average total costs and returns to dryland and irrigated crop production and the difference between the two.

Table 3.2.4
IRRIGATION EXPANSION, INCREMENTAL NET RETURNS TO IRRIGATION

Irrigation Climatic Zone	Dryland Revenue	Dryland Costs	Irrigated Revenue	Irrigated Costs	Total Income Change
			($/acre)		
A1	34.22	16.59	455.23	153.47	284.23
A2	36.70	16.68	358.32	132.71	205.59
B	56.03	27.55	331.91	128.51	174.93
C	54.69	25.80	251.73	103.69	119.15

The financial analysis included all applicable transfer payments (subsidies, taxes, financing costs, etc.). It was assumed that for any on-farm capital investment, the level of farmer equity was zero. The interest rate used for loans was 13 per cent, with a repayment period of 10 years. The results of the financial analysis are given in terms of annual equivalent (or annual average) cash flow and reflect returns to land, labor, management and existing investment (Table 3.2.5).

Table 3.2.5
IRRIGATION EXPANSION, AVERAGE ANNUAL FARM FINANCIAL RETURNS

Irrigation-Climatic Zone	Total Resources	After Financing	After Financing and Taxes
		($/acre/year)	
Intensification (Adjacent to or Within Existing Irrigation Districts)			
A1	175	161	129
A2	117	103	82
B	94	80	64
C	57	43	34
Expansion (Not Adjacent to Existing Irrigation Districts)			
A1	131	121	98
A2	87	78	62
B	70	60	48
C	42	33	26

Irrigation expansion and intensification were shown to be feasible in all irrigation climatic zones examined. All cases withstood irrigation system cost increases of 20 per cent, decreases in crop benefits of 20 per cent and a two per cent increase in the discount rate. The residual value of land and equipment not depreciated was included at the end of the 30-year period of analysis. The residual land value was based on the continuing net returns from irrigation. While this increased land value results partly from off-farm investment, the benefit accrues to the farmer owning the land at the time water delivery becomes available.

Table 3.2.5 also shows the difference between the intensification or extension of irrigation in or adjacent to existing irrigation districts or blocks, and irrigation of new dryland areas away from existing irrigation. The lower financial returns in the case of new areas is primarily due to the more gradual phasing-in of the irrigation invest-

ment. In all cases, irrigation climatic zone A1 shows the highest returns and zone C the lowest of the four, due to the differences in yields and crop mix between these areas.

Irrigation Expansion involving an increase of 1.1 million acres, was estimated to consist of approximately 67 per cent expansion onto land not adjacent to current irrigation districts or blocks, and 33 per cent intensification in or adjacent to currently irrigated areas. This was based on the assumption that the maximum acreage would be irrigated through the extension of the works of existing irrigation districts, with any remaining water placed in "new" districts or areas.

3.2.5 Provincial Economic Effects

Transfer payments were excluded from the provincial economic analysis. Public investment requirements and lost benefits in other sectors were included, the total development was phased in over 100 years. The new irrigated acreage was phased-in in equal annual blocks. Each block also incorporated the respective adoption rate among farmers of 10 and 20 years for intensification and expansion, respectively. Table 3.2.6 shows the direct net benefits.

The expansion of the irrigated land base by 1.1 million acres would require a large public investment in reservoirs, canals and other major works. Table 3.2.6 also presents the costs for off-farm infrastructure. These costs include all public investment required to increase irrigated acreage from its current level of approximately 1.2 million acres to the full potential of 2.3 million acres. Further details on these cost estimates are given in the South Saskatchewan River Basin Planning Program Scenario Report. Public expenditure on storage and headworks was assumed to be phased-in for the first 574 000 acres over 10 years. Expenditure for the remaining acreage was phased-in from years 46-65, with rehabilitation work from years 1 to 30. The present value of total capital infrastructure costs was $1 532 million and that of operating and

Table 3.2.6

IRRIGATION EXPANSION, DIRECT NET BENEFITS[1]

Irrigation Climatic Zone	Gross Margin		On-Farm Investment Cost	On-Farm Net Benefit
		($ million, present value)		
A1	167		23	144
A2	284		53	231
B	11		3	9
C	177		28	119
Total	639		136	503
Public Investment:				
Storage and Headworks		888		
New District Works		28		
Rehabilitation		616		
Operation & Maintenance (to year 100)		115		
Total		1 647		1 647
Lost Hunting Benefits				6
Direct Net Benefits				-1 150 (-$1 010 per acre)

[1] A supplementary analysis showed that if irrigation expansion were limited to the 574 000 acres that could be serviced by the existing districts, and phased-in over 50 years, the total gross margin would be reduced to $526 million, on-farm investments would be $115 million, and the on-farm net benefits would be reduced to $411 million. Total public investment requirements would be $1 473 million, including operation and maintenance costs. Lost hunting benefits would be $5 million, leaving a direct net benefit of -$1 067 million.

maintenance was $115 million. A portion of the new district works and rehabilitation costs would likely be borne by farmers through some cost sharing arrangement.

The lost hunting benefits were based on the change in wildlife production capacity and the resulting change in number of hunters and their willingness to pay for the hunting experience. The total annual

loss of hunting benefits was estimated to be over $1.3 million. With the phasing-in of irrigation development the total loss was estimated to be $6 million in present value terms.

From a provincial perspective, the direct benefits and costs can be summarized to give the societal direct net benefit (Table 3.2.6). The agricultural value added of $639 million less the on-farm investment costs of $136 million leaves an on-farm net present value of $503 million. Subtracting from this the off-farm or public investment requirements of $1 647 million and foregone hunting (willingness to pay) benefits of $6 million, leaves a provincial net present value of -$1 150 million. Against this, the unquantified benefits associated with municipal and industrial water supply and recreational benefits should be considered. It is clear that on the basis of the quantified direct benefits alone, an expansion of 1.1 million acres of irrigated land is not economically feasible.

The impact of Irrigation Expansion on the provincial economy was also analysed in terms of the total direct and secondary value added resulting from this option. Table 3.2.7 summarizes these direct and secondary benefits and costs.

The increase in direct value added (gross revenue less operating costs) in the agricultural sector would be $639 million in present value terms. There would be an increase in activity in other sectors of the provincial economy as a result of both on and off-farm investment totalling $750 million. Thus the total increase in direct provincial value added would be $1 389 million. If secondary benefits are included, total benefits would be $1 948 million.

Total direct benefits lost (i.e. lost willingness to pay plus lost value added from hunting expenditure) in the wildlife sector were estimated to be $12 million. Secondary benefits lost as a result of reduced hunting would be $2 million, giving a total benefit lost of $14 million. The total benefits from this option would therefore be $1 934 million, or $1 698 per acre.

Table 3.2.7

IRRIGATION EXPANSION, VALUE ADDED RESULTS

	Direct Value Added	Secondary Value Added	Total Value Added
	($ million, present value)		
Benefits Gained			
Agriculture	639	234	873
Public & Private Investment	750	325	1 075
Total	1 389	559	1 948
Benefits Lost			
Hunting	12	2	14
Value Added Change	1 377	557	1 934

While the analysis of direct benefits and costs showed that net agricultural returns were not sufficient to offset the large public investment requirements, the expansion of irrigation appears economically feasible when the value added resulting from investment is treated as a provincial benefit. In other terms, irrigation is an attractive option not only to those farmers who would participate, but also to indirect beneficaries in the province. This is true whether or not estimated secondary benefits are included in the analysis.

3.2.6 Summary of Irrigation Expansion Results

Potential Scale	
Potential Acreage for Development	1.1 million acres
Annual Agricultural Production Potential	$306 million ($268 per acre)
Annual Farm Financial Returns	$23 to $130/acre
Economic Results (Present Value)	
Gross Revenue	$1 027 million
less operating costs	388
On-Farm Value Added	$ 639
less on-farm investment costs	136
On-Farm Net Benefit	$ 503
less public investment costs	1 647
lost hunting benefits	6
Net Direct Benefits	-$1 150 million (-$1 014 per acre)
Growth in Provincial Economy (Present Value)	
Direct Net Value Added	$1 377 million
Secondary Net Value Added	$ 557
Total Value Added Change	$1 934 million ($1 698 per acre)

Potential Significant Impacts:

Negative: Wildlife, Soil Salinity, Water Quality

Positive: Municipal and Industrial Water Supply, Soil Conservation, Agricultural Stabilization, Water-Based Recreation.

3.3 Drainage

3.3.1 General Description

Much of the agricultural land base in Central and Northern Alberta is affected by excess moisture. In some areas of Central Alberta, potholes and sloughs are the predominant type of wetland, often associated with undulating or "knob and kettle" topography. In the northern portion of the central White Area and in large areas of the Peace River region, organic soils form wetlands which may be classified as bogs (often consisting of accumulations of moss and usually acidic in nature) or fens (typically formed from accumulations of sedge material). In some of the level areas of the Peace River region, where heavy soils limit the rate of water percolation into the soil, large areas of "sheetwater" or temporarily flooded cultivated land can be found. In Southern and Central Alberta, where wetlands are less numerous, saline seeps comprise a larger fraction of the total wetland acreage.

On-farm drainage of agricultural land can involve a combination of several techniques. The most common approach is the construction of surface ditches. These may be constructed with broad side slopes to allow field equipment to cross easily. They may also be grassed to prevent soil erosion. Subsurface drains, commonly consisting of perforated plastic tubing, may also be used.

Several techniques are also available to reduce the impact of drainage on the downstream water course, as well as to provide additional on-farm water storage. The most common is the consolidation of drainage water into a dugout or permanent wetland. This makes water available for stock watering, supplemental irrigation, wildlife and other uses. Consolidation also reduces peak flows leaving the farm which in turn reduces the cost of off-farm drainage construction and the impact on natural watercourses.

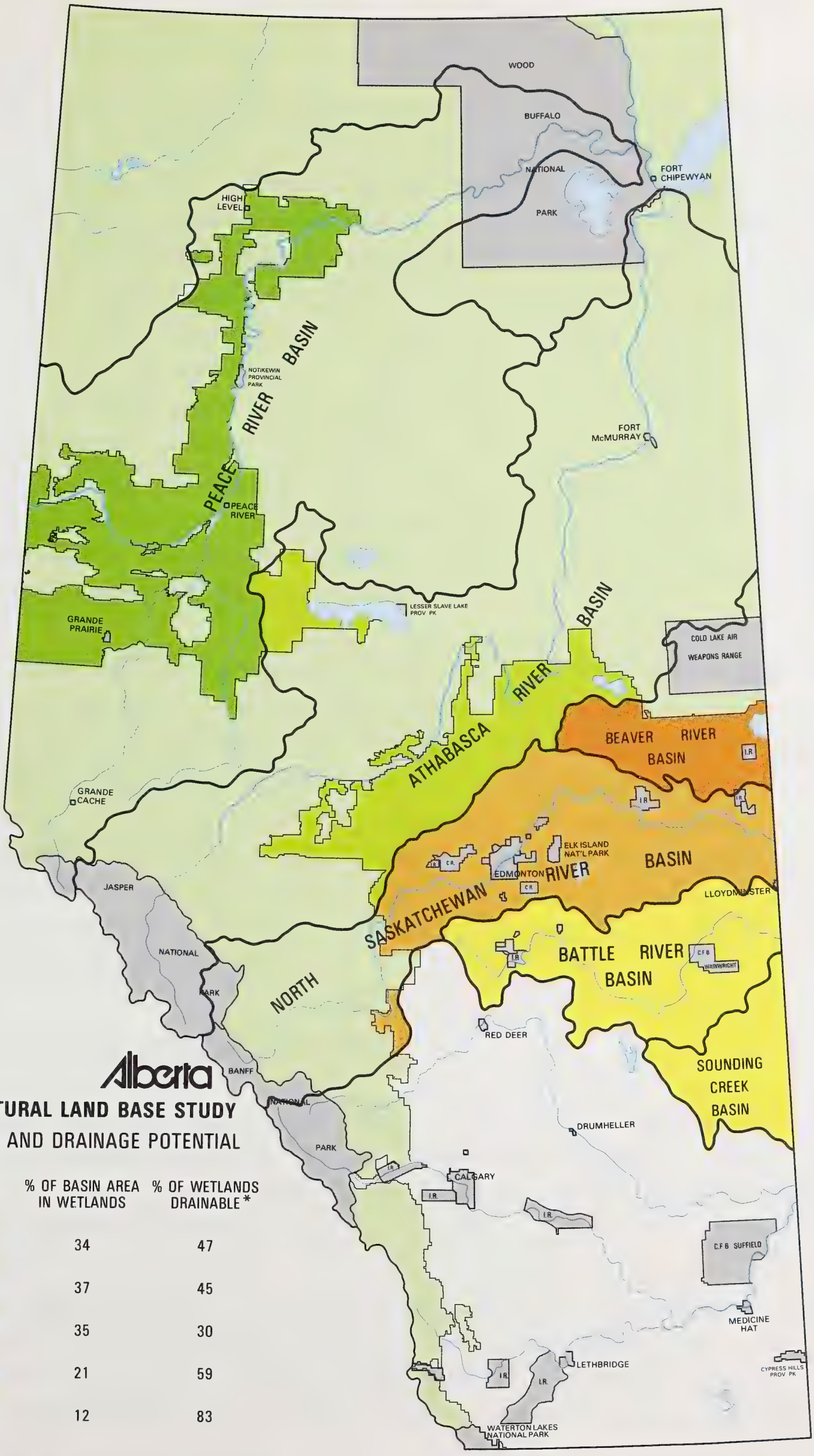
3.3.2 Agricultural Inventory

Information on wetland acreage and drainage potential is taken from the Drainage Potential in Alberta - An Integrated Study. The inventory was conducted to determine the extent and type of wetlands in the White Area, as well as several characteristics which would have a bearing on agricultural development potential and wildlife habitat quality. Six types of wetlands were distinguished: slough/marsh, lake/pond, bog/fen, sheetwater, seep and watercourse. The slough/marsh type was described as permanent or non-permanent. The identification of permanent slough/marsh was based on the presence of aquatic vegetation. The inventory of wetlands was conducted by interpreting aerial photographs from a sample of townships throughout the White Area. The results of the inventory, based on an extrapolation of the sample findings, are presented in Table 3.3.1. The river basins which were studied are shown in the Wetlands and Drainage Potential map.

Table 3.3.1
DRAINAGE, SUMMARY OF WETLANDS INVENTORY BY RIVER BASIN[1]

		Non-Permanent				Permanent			
River Basin	Basin Area	Temporary Slough/Marsh	Sheetwater	Seep	Total Non-Permanent	Bog/Fen	Lake/Pond and Permanent Slough/Marsh	Watercourse	TOTAL
				(thousands of acres)					
Athabasca	5 391	52	111	0	163	1 460	292	82	1 997
Battle	8 317	830	0	6	836	0	86	87	1 009
Beaver	2 327	37	0	0	37	405	308	59	809
North Sask.	8 663	803	0	0	803	563	205	246	1 817
Peace	11 244	75	206	0	281	3 062	85	390	3 818
TOTAL WETLANDS	35 942	1 797	317	6	2 120	5 490	976	864	9 450

1. Based on economic and physical considerations, non-permanent wetlands (temporary slough/marsh, seep and sheetwater) are the most suitable types of wetlands for agricultural drainage. Up to half the bog/fen type may also be suitable for drainage.



Alberta

AGRICULTURAL LAND BASE STUDY

WETLANDS AND DRAINAGE POTENTIAL

RIVER BASINS	% OF BASIN AREA IN WETLANDS	% OF WETLANDS DRAINABLE*
(dark green)	34	47
(light green)	37	45
(orange)	35	30
(light orange)	21	59
(yellow)	12	83

*INCLUDES NON-PERMANENT WETLANDS AND POTENTIALLY DRAINABLE PEATLANDS.

PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA FORESTRY, LANDS AND WILDLIFE, 1986.

The inventory results indicate that the total wetland acreage is concentrated in Central and Northern Alberta, with over 80 per cent occurring north of and including the Battle River basin. Bogs and fens account for the largest acreage and are concentrated in the Peace and Athabasca River basins, and to a lesser degree in the Beaver and North Saskatchewan River basins in areas less intensively developed for agriculture. The economic analysis determined that the drainage of non-permanent wetlands would be economically feasible, while permanent wetlands would not. Non-permanent wetlands include temporary sloughs/marshes, seeps and sheetwater. Table 3.3.1 shows a total of 2.1 million acres of non-permanent wetlands in the White Area portion of the five river basins in Central and Northern Alberta. Drainage of 2.1 million acres of non-permanent wetlands would lead to $241 million of additional agricultural output annually.

In that part of the province there is also a large area of bog/fen wetlands or peatlands. It was not possible to determine the potential drainability of these peatlands. However, independent estimates place the overall drainage potential of peatlands as high as 50 per cent, or an additional 2.7 million acres of potentially drainable acreage. The drainage of 2.7 million acres of bog/fen wetlands would produce an additional $242 million annually. For the purpose of the Agriculture Land Base Study, only 2.1 million acres of non-permanent wetlands were considered suitable for drainage.

3.3.3 Impacts On Other Resource Users

The analysis of impacts on wildlife was initally conducted on the basis of the administrative regions of Alberta Forestry, Lands and Wildlife. These results were extrapolated to the five major river basins, shown in the Drainage map.

Wetlands perform a variety of valuable functions, both directly and indirectly, to a wide range of resource users. One major function which they serve is the buffering or averaging of flow rates in streams and creeks. Permanent sloughs, bogs and fens typically provide significant

water storage for spring snow melt and runoff from summer storms. Drainage reduces or eliminates this storage and accelerates and increases runoff. Without special controls this accentuated runoff can cause considerable downstream damage, i.e. flooding of agricultural and other land, stream channel erosion and the destruction of bridges, roads and other works.

The impact on downstream landowners and other users can be minimized by having adequate drainage outlets. In many cases these off-farm impacts could be reduced substantially by restricting the rate of flow to receiving streams through the use of on-farm water consolidation or other means. This approach to reducing the impacts of drainage on downstream landowners is necessary because some damage, such as erosion, tends to quickly become worse if corrective measures are not taken. Total impacts are lowest if adequate designs are implemented initially.

Wetlands vary considerably in their wildlife habitat value. Permanent and temporary sloughs, particularly in association with surrounding natural upland vegetation, provide a high degree of habitat value. In contrast, both saline seeps and sheetwater have little habitat value. If all non-permanent wetlands in Central and Northern Alberta were drained and the immediately surrounding vegetation cleared, close to 25 per cent of the provincial waterfowl habitat would be lost resulting in a 21 and 33 per cent reduction in Alberta's duck and Canada goose production, respectively. Other wildlife groups such as ungulates, upland bird game and aquatic furbearers would suffer smaller habitat losses. In addition to the species which support a major consumptive use, a wide range of other species would be harmed by extensive drainage. The impact on fisheries would be considerably less, unless drainage disrupted major streams and rivers.

Wetlands provide a number of other important benefits. Many serve as recharge areas for groundwater. In some parts of the province excess groundwater and resulting seepage are problems, but in many areas groundwater provides a vital water source for domestic and other uses.

The impact on groundwater recharge is not clear, but significant impacts may occur from widespread drainage. Wetlands also serve to improve water quality because sediment, nutrients and other contaminants are trapped by aquatic vegetation. Temporary wetlands are also important sources of forage in some areas, and in dry years they support large numbers of livestock. Complete drainage would eliminate much of this forage.

3.3.4 Farm Financial Effects

The analysis of drainage feasibility was based on an investigation of five small representative watersheds or mini-basins. These were assumed to be representative of the larger river basins in which they are located. They contained the major wetland types and topographic features found in the settled portion of Central and Northern Alberta. The mini-basins were: Silver Creek, southwest of Camrose; Shoal Creek, north of Barrhead; Lalby Creek, north of Falher; Dunvegan Creek, which includes the town of Spirit River; and Tee Pee Creek, south of Fort Vermilion.

The financial feasibility was examined to measure the profitability of on-farm drainage, given existing support programs and investment costs to the farmer. The analysis was conducted with and without financing costs and before and after deducting income taxes. The results given in Table 3.3.2 are expressed as a change in annual average cash flow. This represents returns to land, labor, management and existing capital. Interest was charged at 13 per cent on all new investments and a marginal tax rate of 20 per cent was used. A residual value for the land improvement was included in the final year of the 30 year project life.

Drainage of temporary wetland would be financially feasible to the farmer in each of the five river basins studied. Drainage in the Battle River basin, represented by Silver Creek, was the most attractive to the farmer. Drainage in the Beaver River Basin, represented by Shoal Creek, was least attractive.

Table 3.3.2

DRAINAGE, AVERAGE ANNUAL FARM FINANCIAL RETURNS

	Total Resources	After Financing	After Financing and Tax
		($/acre/year)	
Peace	36	31	27
Athabasca	28	23	20
Beaver	23	17	16
North Saskatchewan	57	45	39
Battle	67	52	45

Sensitivity analysis showed that on-farm drainage would remain feasible with 20 per cent reductions in benefits or 20 per cent increases in incremental costs. It would also withstand exclusion of a residual value at the end of 30 years.

3.3.5 Provincial Economic Effects

The provincial economic analysis was undertaken for each of the five major river basins. For the economic analysis, the acreage in each mini-basin was extrapolated on the basis of wetland type and frequency, to represent the larger river basins. The results of this extrapolation are shown in Table 3.3.3. The Beaver and Battle River basins were represented entirely by Shoal and Silver Creeks respectively, while the other three basins were represented by a mix of mini-basins. Results of the economic analysis for each mini-basin were calculated on a per acre basis and were then weighted and scaled up to the extrapolated acreage values.

Table 3.3.3

DRAINAGE, WETLAND ACREAGES REPRESENTED BY MINI-BASINS

Representative Mini Basin	River Basin				
	Peace	Athabasca	Beaver	N. Sask.	Battle
	(per cent)				
Silver	0	0	0	76	100
Lalby	0	6	0	0	0
Teepee	23	7	0	4	0
Dunvegan	18	0	0	0	0
Shoal	59	87	100	20	0
Totals	100	100	100	100	100

The total acreage examined for each major basin was phased-in over 100 years. Direct net benefits for each basin are presented in Table 3.3.4. The net agricultural benefit for the entire acreage (2.1 million acres) was $410 million. This was made up of $183 million for the Battle River basin and $227 million for the remaining areas. The total off-farm infrastructure as a public investment cost was $373.5 million for the entire acreage. On-farm plus off-farm investment costs totalled $701.7 million. The present value of big game and waterfowl hunting benefits lost (measured as willingness to pay) were estimated at $13.9 million. Trapping benefits lost were $0.26 million in present value terms. The net benefit to society was therefore $23 million.

Table 3.3.4

DRAINAGE, DIRECT NET BENEFITS

River Basin	Total Area	Gross Margin	On-Farm Investment Cost	On-Farm Net Benefit
	(Thousand acres)	($ million, present value)		
Peace	281	76.2	30.9	45.3
Athabasca	163	42.1	21.7	20.4
Beaver	37	9.4	5.5	3.9
North Saskatchewan	803	286.5	128.5	158.0
Battle	836	324.6	141.6	183.0
Total	2 119	738.8	328.2	410.0
Public Investment				373.5
Lost Hunting and Trapping Benefits				14.1
Direct Net Benefits				23.0 ($11 per acre)

Drainage produced a direct agriculture value added of $739 million and a secondary or indirect value added of $250 million for a total agricultural value-added of $989 million (Table 3.3.5). Value added benefits less wildlife losses were $993 million (direct) and $373 million (secondary) for a total value added of $1 366 million.

Table 3.3.5

DRAINAGE, VALUE ADDED RESULTS

	Direct Value Added	Secondary Value Added	Total Value Added
	($ million, present value)		
Benefits Gained			
Agriculture	739	250	989
Public and Private Investment	281	127	408
Total Benefits Gained	1 020	377	1 397
Benefits Lost			
Hunting and Trapping	26	5	31
Value Added Change	993	373	1 366

The measured economic impact on other resource uses was confined to wildlife hunting and trapping benefits that would be lost as a result of drainage. As with other agriculture development alternatives which would affect wildlife, drainage would affect the consumptive as well as non-consumptive use of wildlife. Off-farm infrastructure costs were derived from mini-basin costs. Possible effects on the water quality and other environmental impacts were not included in the assessment, but should be considered in addition to the economic results shown above. Individual projects would not have a significant effect but drainage of all temporary wetlands in any given basin could require downstream structures to prevent flooding at a potentially high cost.

3.3.6 Summary of Drainage Results

Potential Scale

Potential Acreage for Development	2.1 million acres[1]
Annual Agricultural Production Potential	$241 million ($114 per acre)

Annual Farm Financial Returns — $16 to $45 per acre

Economic Results (Present Value)

Gross Revenue (incl. reduced farming costs)	$ 887 million
less operating costs	148
On-Farm Value Added	$ 738
less on-farm investment costs	328
On-Farm Net Benefit	$ 410
less public investment costs	373
lost hunting and trapping benefits	14
Net Direct Benefits	$ 23 million ($11 per acre)

Growth in Provincial Economy (Present Value)

Direct Net Value Added	$ 993 million
Secondary Net Value Added	$ 373
Total Value Added Change	$1 366 million ($644 per acre)

Potential Significant Impacts

Negative: Wildlife, Water Resources.

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[1] An additional 2.7 million acres of peatlands may have drainage potential, but are not included in the financial and economic results.

3.4 Deep Plowing

3.4.1 General Description

Solonetzic soils are characterized by a tough impermeable hardpan subsoil layer. This hardpan severely restricts root and water penetration and nutrient uptake which are vital to plant growth. Plant growth is restricted to the narrow band of soil between the hardpan layer and the surface, with crop productivity ranging from very low to near that of the associated normal soils, depending upon the depth of the topsoil. Crop yields also vary from year to year, depending on the distribution of rainfall. More available moisture at the surface reduces the need for deeper root penetration, although excessive moisture can cause water-logging and crop damage.

A number of management practices, including deep plowing, and ripping and liming, have been developed to correct the problem. All have been shown to improve crop yields. This study deals only with deep plowing, a practice which breaks up the hardpan layer and produces a chemical balance which prevents it from reforming. If soil conditions are appropriate, deep plowing should be a one-time treatment.

3.4.2 Agriculture Inventory

Solonetzic soils are distributed over a relatively large area of Alberta in both grain producing and mixed farming areas. Approximately 10.7 million acres of land are influenced by solonetzic soils. While these soils are widespread throughout the province, not all would benefit from deep plowing. Solonetzic soils in the Peace River region are not considered suitable because formation of the hardpan layer is due to their high clay content rather than the typical development from parent materials naturally high in, or enriched with sodium salts. The Gray (Central) Soil Zone was also excluded from this analysis due to the minor occurrence of solonetzic soils and because no deep plowing yield information is available. Further, not all solonetzic soils respond equally to deep plowing. For this study it was assumed that 60 percent of the

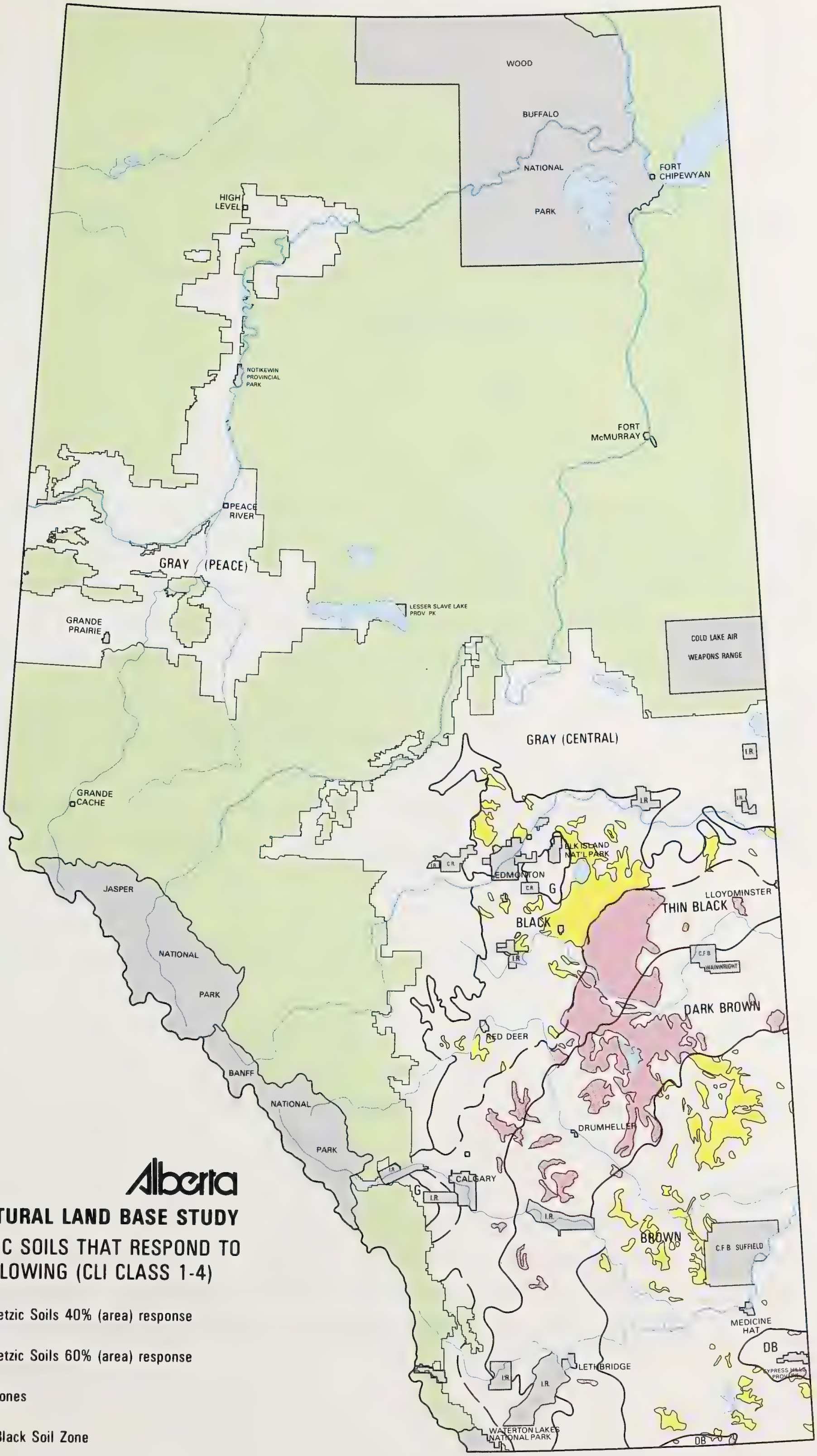
solonetzic soils in the Thin Black and Dark Brown soil zones and 40 percent of the soils in the Black and Brown soil zones would respond. These are illustrated in the Solonetzic Soils That Respond To Deep Plowing map. Deep Plowing is estimated to be effective on only 20 per cent of the total of 10.7 million acres of these soils. Only arable (CLI Class 1 to 4) soils are included in the acreage estimates in Table 3.3.1.

Table 3.4.1

DEEP PLOWING, SOLONETZIC SOILS SUITABLE FOR DEEP PLOWING

Soil Zone	Area
Black Soil Zone	(thousand acres)
Northern portion	520
Thin Black portion	650
Dark Brown Soil Zone	530
Brown Soil Zone	520
Total	2 220

Crop yield response is highest in the Thin Black and Dark Brown soil zones. In these areas the physical characteristics of the solonetzic soils are a more significant limitation on crop growth. In the Brown soil zone, moisture deficiencies continue to limit yields, while in the Black soil zone, particularly during years of adequate moisture, solonetzic soils produce reasonably good yields. Yield estimates are only provided for wheat, oats, barley and canola as no information was available for hay. The representative crop mixes were further adjusted for the Brown and Dark Brown Soil Zones where no data were available for canola. Production increases were derived from available field plot data and are based on the incremental increases associated with the actual response to deep plowing (Table 3.4.2).



PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA ENERGY AND NATURAL RESOURCES, 1985.

Table 3.4.2

DEEP PLOWING, INCREMENTAL YIELDS

Soil Zones	Wheat	Oats	Barley	Canola
		(bushels/acre)		
Black	12.7	18.7	25.5	6.4
Dark Brown	7.4	15.7	4.5	N/A
Brown	5.4	24.3	8.1	N/A

The increased value of agricultural production resulting from deep plowing 2.22 million acres of solonetzic soils would be approximately $83 million a year. Historically, the rate of adoption for has been very low. It is estimated that less than 500 acres per year are deep plowed, with a total of between 2 000 and 5 000 acres treated in Alberta.

3.4.3 Impacts On Other Resource Users

No potential impacts on other resource users have been identified because it was assumed that deep plowing would take place on private land already in cultivation.

3.4.4 Farm Financial Effects

The financial analysis included the costs and returns and transfer payments associated with each soil zone and crop. For this analysis, replowing was assumed to be required after 10 years, with some residual effect beyond 10 years. The present value of this treatment over 10 years was $93 per acre. The analysis was also based on the assumption that one 80-acre parcel in a farm unit would be reclaimed. The results are annual equivalent (or annual average) cash flows and represent returns to labor, management and existing investment. They also include the residual value of land and equipment at the end of the 10 years (Table 3.4.3).

Table 3.4.3

DEEP PLOWING, AVERAGE ANNUAL FARM FINANCIAL RETURNS

Soil Zone	Total Resources	After Financing	After Financing & Tax
		($/acre/year)	
Black	48.30	46.18	38.27
Dark Brown	21.13	19.00	16.53
Brown	19.37	17.25	15.13

Deep Plowing is financially feasible for farmers even after the full cost of financing the investment and taxes are included. This option is most attractive in the Black soil zone, based on the significantly higher yield increments resulting from treatment in that zone. No distinction was made in this analysis between Black and Thin Black soils.

The fairly strong financial results for this option indicate that the level of risk is low. Lower than expected yield response or crop prices do not affect the options financially feasibility. In each soil zone the improvement withstood 20 percent decreases in prices or 50 per cent increases in plowing costs. It was also viable with a two percent increase in the discount rate or a slower yield response rate such as a gradual increase from 15 per cent in year three to 100 per cent of the expected increase in year eight. Given the low historic rate of adoption, it would appear that more demonstration and information on its potential would have a positive effect on the rate of adoption this type of development.

3.4.5 Provincial Economic Effects

The economic analysis excludes those transfer payments (taxes, subsidies and financing costs) which were included in the financial analysis. Also, an infinite stream of benefits and costs was assumed, with periodic reinvestment and phasing-in over 50 years. The direct benefits and costs resulting from reclamation of 2.22 million acres of solonetzic soils are shown in Table 3.4.4.

Table 3.4.4

DEEP PLOWING, DIRECT NET BENEFITS

Soil Zone	Acreage	Gross Margin	Investment Costs	On-farm Net Benefits
	(thousand acres)	($ million, present value)		
Black	1 170	400	77	323
Dark Brown	530	88	35	53
Brown	520	80	34	46
Total	2 220	568	146	422

Deep Plowing of solonetzic soils would involve no public infrastructure development. There are no identified impacts or lost benefits for other resource sectors. From a total provincial value added perspective, the benefits of Deep Plowing consist of the value added resulting from additional agricultural production and the increased value added in other sectors as a result of on-farm investment (Table 3.4.5).

Table 3.4.5

DEEP PLOWING, VALUE ADDED RESULTS

Benefits Gained	Direct Value Added	Secondary Value Added	Total Value Added
	($ million, present value)		
Agriculture	568	--	568
Deep Plowing Investment	101	26	127
Value Added Change	669	26	695

It was assumed that the increased agricultural production would not require an increase in inputs other than the deep plowing investment itself. Secondary benefits are associated with the investment component. The value added resulting from investment is a benefit since it constitutes new income in other sectors of the economy.

The study did not provide a regional breakdown of the secondary benefits. Many of these benefits would occur in the same regions in which the increased agricultural production is produced, but some would occur in other areas such as major supply centres. The breakdown of acreage and net benefits shown in Table 3.4.4 can, however, be used as an appoximate indication of the location of secondary and total provincial value added benefits.

3.4.6 Summary of Deep Plowing Results

Potential Scale

Potential Acreage for Development	2.2 million acres
Annual Agricultural Production Potential	$83 million ($37 per acre)

Annual Farm Financial Returns	$15 to $38 per acre

Economic Results (Present Value)

Gross Revenue	$568 million
less operating costs	0
On-Farm Value Added	$568
less on-farm investment costs	146
Net On-Farm Benefit	$422
less public investment costs	0
lost benefits	0
Net Direct Benefits	$422 million ($190 per acre)

Growth in Provincial Economy (Present Value)

Direct Value Added	$669 million
Secondary Value Added	26
Total Value Added Change	$695 million ($313 per acre)

Potential Significant Impacts:

None

3.5 Liming

3.5.1 General Description

Soil acidity or alkalinity, expressed as pH, affects the physical, chemical and biological properties of soils, which, in turn, affect nutrient availablity and crop yields. Soils with pH lower than 6.0 are considered acidic. The major cause of yield reductions on acid soils is increased crop toxicity to soluble aluminum and manganese at lower pH levels. Nitrogen-fixing bacteria are also not active in acid soils. While soils with a pH in the range of 6.1 to 6.5, are potentially acidic, their yield potential is not affected. Soils in the 6.5 to 7.5 pH range are considered neutral and ideal for most agricultural crops. Acid soils occur naturally due to acidic parent material or leaching of alkaline materials during soil formation. Soil acidity also results from activities such as, tillage and fertilizer use.

To overcome the problems of soil acidity, acid tolerant crops can be grown, or lime can be applied to neutralize the soil. Cereal and oilseed crops vary greatly in their tolerance to acidity and different varieties of a crop may also show a range of acid sensitivity. Ground limestone and marl are the most common neutralizing materials, with application rates depending on the degree of acidity, the soil's buffering capacity and the effectiveness of the liming material. Correcting the pH of acid soils requires one or more 0.9 tons of lime per acre every five to 10 years, depending on cropping practices, fertilizer rates, soil type and pH level.

3.5.2 Agriculture Inventory

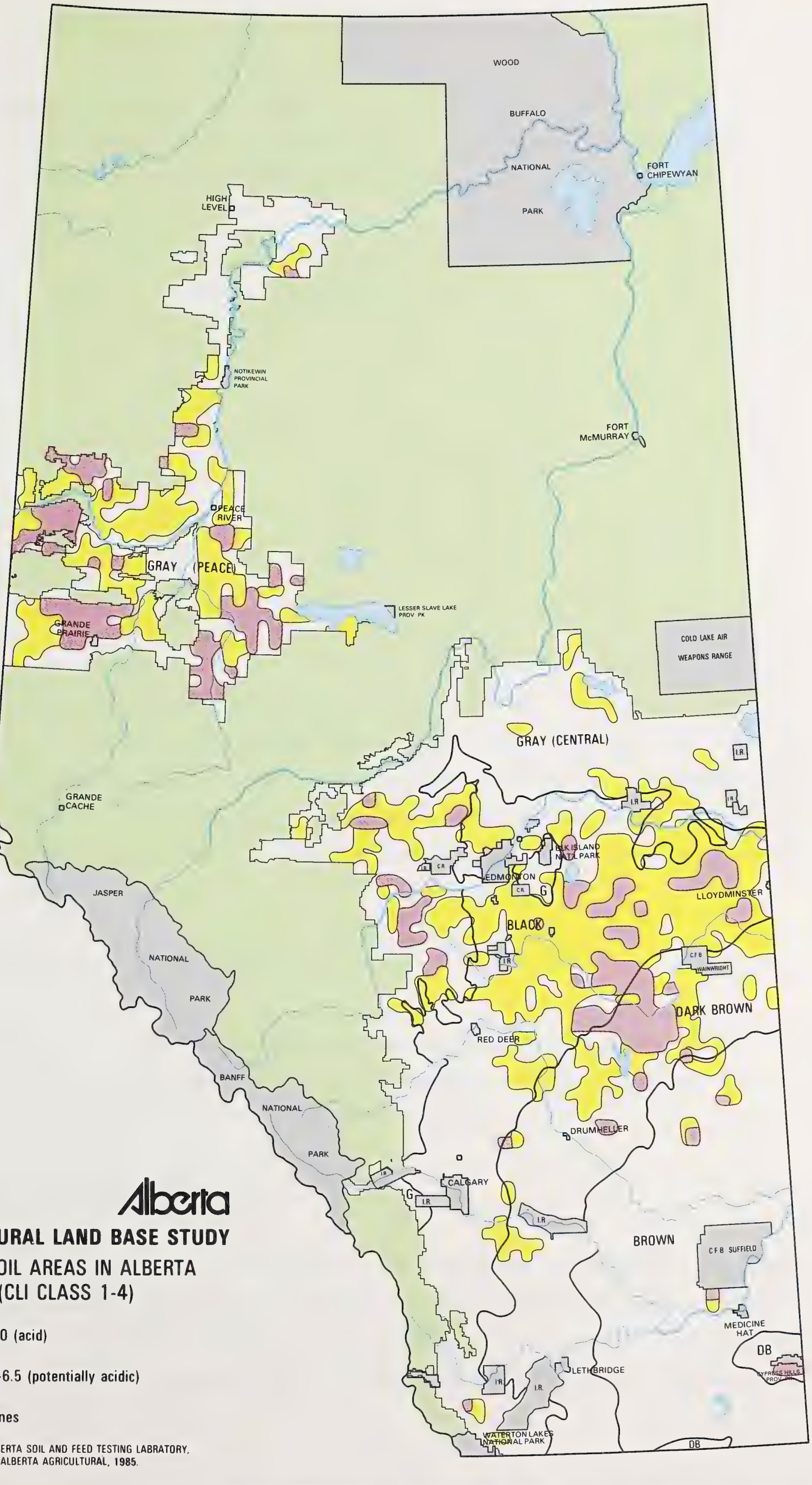
Seventy per cent of the acid soils in Western Canada are found in Alberta. The largest concentration of acid soils is found in the Peace River region, with another large area being found in the Black and Dark Brown soil zones in east-central Alberta. These are illustrated in the

map Acid Soil Areas in Alberta. Much of the soil acidity in Alberta is associated with solonetzic soils, which tend to have an acidic surface layer. To avoid double counting, those acid soils which are also solonetzic and suitable for deep plowing have been excluded from the estimated area for liming. However, it is also assumed that half of the solonetzic/acid soils which are not suitable for deep plowing can be ripped and limed, while the rest are believed to have excessive, multiple limitations which would make them unsuitable for liming. Only CLI Class 1-4 lands are included in the estimated acreages of acid soils suitable for liming, shown in Table 3.5.1.

Table 3.5.1
LIMING, ACID SOILS SUITABLE FOR LIMING

Soil Zone	Area
	(thousand acres)
Black	940
Dark Brown	230
Brown	90
Gray	
- Central	310
- Peace	1 030
Total	2 600

An even larger number of acres of potentially acidic soil are found in Alberta: 1.34 million acres in the Peace River region and 4.8 million acres in the remainder of the province. In the future, millions of acres may become acidic due to nitrogen fertilizer use. The location of these potentially acidic soils are also shown in the Acid Soil Areas in Alberta map. Potentially acidic soils are not included in the estimated acreage for liming, nor in the subsequent analyses, as they do not affect crop yields.



Alberta

AGRICULTURAL LAND BASE STUDY

ACID SOIL AREAS IN ALBERTA (CLI CLASS 1-4)

- pH ≤ 6.0 (acid)
- pH 6.1-6.5 (potentially acidic)
- Soil Zones

SOURCE: ALBERTA SOIL AND FEED TESTING LABRATORY, ALBERTA AGRICULTURAL, 1985.

PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA ENERGY AND NATURAL RESOURCES, 1985.

Increases in yields are shown in Table 3.5.2. Yields after liming are assumed to equal those on neutral soils. Oats are the most tolerant to acidity while barley is the most sensitive.

Table 3.5.2
LIMING, INCREMENTAL YIELDS

Soil Zones	Wheat	Oats	Barley	Canola
		(bushels/acre)		
Black	5.7	5.0	9.8	3.6
Dark Brown	5.2	4.8	10.2	3.9
Brown	4.1	3.3	8.8	2.9
Gray (Central)	5.2	4.9	8.8	2.9
Gray (Peace)	4.8	4.5	7.7	2.6

Based on average prices and crop mix, the estimated potential increase in annual crop production is $50 million. Of this, approximately half is due to increased barley yields. Historically, the rate of liming has been less than 5 000 acres a year in Alberta. Approximately 20 000 to 30 000 acres of acid soils have been limed, most coinciding with the implementation of the Alberta Lime Freight Assistance program in 1981.

3.5.3 Impacts On Other Resource Users

No potential impacts on other resource users have been identified in this study. Liming of acid soils is assumed to take place on private land already in cultivation.

3.5.4 Farm Financial Effects

The financial analysis was based on the costs and returns for each crop and soil zone, and on the relevant transfer payments, such as taxes, subsidies and financing costs. A 10-year analysis was used. The cost of lime, transportation and application were assumed to be $10, $25 and $3 a ton, respectively.

Liming was financially feasible on each soil zone examined. It remained viable with 20 per cent decreases in revenue or 20 per cent increase in liming costs, or a two percent increase in the discount rate. The results are average annual cash flows and represent returns to labor, management and existing investment. They also include the residual value of the land improvement at the end of the 10 years (Table 3.5.3). An additional 90 000 acres of acid soils suitable for liming are found in the Brown Soil Zone, but because of insufficient information, an economic analysis could not be completed for this soil zone.

Table 3.5.3

LIMING, AVERAGE ANNUAL FARM FINANCIAL RETURNS

	Total Resources	After Financing	After Financing and Tax
		($/acre)	
Gray	12.20	9.50	8.83
Dark Brown	13.76	10.71	9.34
Black	13.89	11.20	9.74

3.5.5 Provincial Economic Effects

The direct benefits and costs resulting from the treatment of 2.51 million acres of acid soils are given in Table 3.5.4. Liming, like Deep Plowing, does not involve public infrastructural developments. This option also has no identified lost benefits for other resource sectors.

Table 3.5.4

LIMING, DIRECT NET BENEFITS

Soil Zone	Acreage	Gross Margin	Investment Costs	On-farm Net Benefit
	(thousand acres)	($ million, present value)		
Gray				
- Peace	1 030	84	39	45
- Central	310	26	12	14
Black	940	88	35	53
Dark Brown	230	21	9	13
Total	2 510[1]	219	95	124

[1] Excludes 90 thousand acres of acid soils in the Brown Soil Zone.

From a total provincial value added perspective, the benefits are the value added resulting from additional production and the increased value added in other sectors resulting from on-farm investment (Table 3.5.5).

Table 3.5.5

LIMING, VALUE ADDED RESULTS

Benefits Gained	Direct Value Added	Secondary Value Added	Total Value Added
	($ million, present value)		
Agricultural Output	219	--	219
Liming Investment	52	23	75
Value Added Change	271	23	294

As with the Deep Plowing of solonetzic soils analysis, the assumption was made that the increased production would not require anything but the liming investment itself. Therefore, no secondary benefits are estimated for the increased agricultural output. Secondary benefits are, however, associated with the investment in liming.

The analysis did not provide a regional breakdown of the secondary benefits. Many of these would occur in the same regions of increased production, while some would also occur in other areas such as major supply centres. The breakdown of acreage and net benefits shown in Table 3.5.4 can, however, be used as an approximate location of secondary and total provincial value added benefits.

3.5.6 Summary of Liming Results

Potential Scale	
Potential Acreage for Development	2.5 million acres[1]
Annual Agricultural Production Potential	$50 million ($20 per acre)
Annual Farm Financial Returns	$9 - $10 per acre
Economic Results (Present Value)	
Gross Revenue	$219 million
less operating costs	0
On-Farm Value Added	$219
less on-farm investment costs	95
On-Farm Net Benefit	$124
less public investment costs	0
lost benefits	0
Net Direct Benefits	$124 million ($48 per acre)
Growth in Provincial Economy (Present Value)	
Direct Value Added	$271 million
Secondary Value Added	$ 23
Total Value Added Change	$294 million ($117 per acre)
Potential Significant Impacts:	
None	

[1] There are and additional 90 thousand acres of acid soils in the Brown Soil Zone. This area was excluded from the financial and economic analyses because of a lack of information.

3.6 Summerfallow Reduction

3.6.1 General Description

Summerfallow is cultivated land left uncropped during the growing season. Since the dry years of the 1930s, summerfallowing has been an integral part of crop rotations throughout the province, especially in the low moisture regions of Southern Alberta. Perceived advantages of fallowing include weed control, moisture storage, and accumulation of plant nutrients, particularly nitrogen, all of which contribute to higher yields. Increased soil moisture provides increased production stability due to more consistent yields.

The increased usage of fertilizers and herbicides for soil fertility and weed control has decreased the yield advantages of summerfallowing. This reduction in yield advantage varies substantially from one region to another, primarily due to the amount of precipitation. Lower yield advantages and research documenting soil degradation processes indicate that a reduction in summerfallow acreage is both practical and necessary for resource conservation. Decreased soil organic matter, erosion and salinization are examples of degradation processes associated with summerfallowing.

3.6.2 Agriculture Inventory

Provincially, the trend over the past 10 years has been toward a reduction in summerfallow in all soil zones except the Brown. The potential reduction in summerfallow and the accompanying increase in cropped acreage, were estimated on the basis of both the current level of summerfallow and the projected levels to which it could be reduced in each of the major soil zones. To reflect lower levels of summerfallow in current farming practices, acreages were taken from the 1981 Census of Agriculture rather than being averaged over a longer period. Potential fallow acreage estimates were taken from reports by the Canada

Grains Council and Hedlin. The current summerfallow acreages and estimated opportunities for reduction are shown in Table 3.6.1. The target levels for summerfallow reduction by soil zones are shown in the Percentage of Cultivated Area in Summerfallow map.

Table 3.6.1

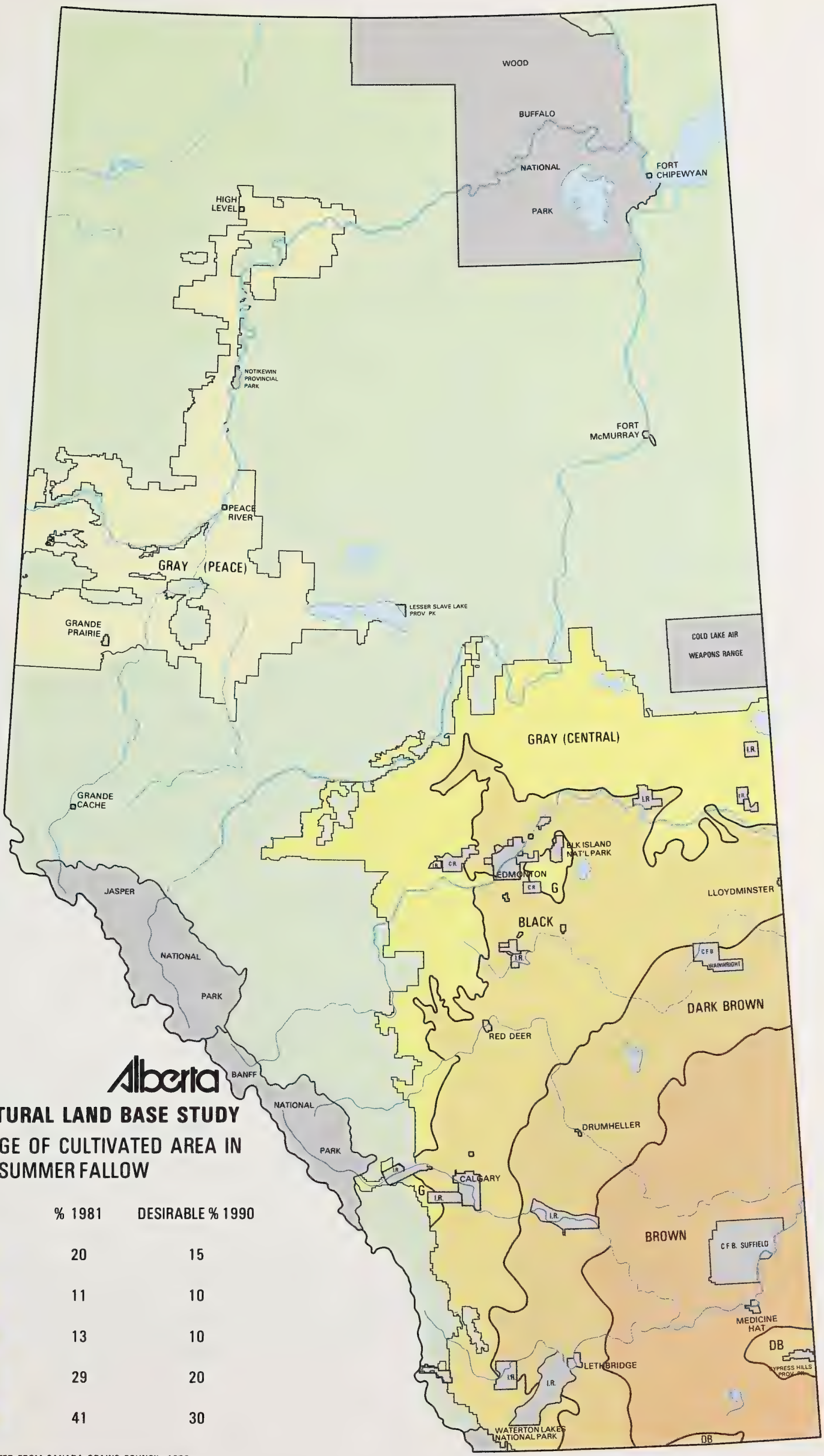
SUMMERFALLOW REDUCTION, PROJECTED ACREAGE

Soil Zone	1981 Summerfallow Acreage	Summerfallow Acreage After Reduction	Acres Available for Crop Production
		(million acres)[1]	
Black	1.23 (13)	0.96 (10)	0.26 (3)
Dark Brown	1.48 (29)	1.02 (20)	0.46 (9)
Brown	1.69 (41)	1.24 (30)	0.45 (11)
Gray (Central)	0.28 (11)	0.25 (10)	0.03 (1)
Gray (Peace)	0.75 (20)	0.57 (15)	0.18 (5)
Provincial Total	5.44 (21)	4.06 (16)	1.38 (5)

[1]Figures in brackets indicate per cent of cultivated acreage

The projected proportion of land devoted to summerfallow varies among the soil zones due to physical or climatic limitations. Moisture stress areas, such as the Brown Soil Zone, still use significant amounts of fallow.

Production increases are based on average yields in each soil zone, reflecting both stubble and fallow yields, and representative crop mixes for each zone. Where fallow land is put into production, yields are assumed to increase from zero to average levels. It is estimated that a reduction of 1.37 million acres of summerfallow in Alberta would result in a $137 million increase in the gross value of annual crop production. The historical rate of Summerfallow Reduction has averaged 150 000 to 200 000 acres a year in recent years.



AGRICULTURAL LAND BASE STUDY

PERCENTAGE OF CULTIVATED AREA IN SUMMER FALLOW

SOIL ZONE	% 1981	DESIRABLE % 1990
(pale green)	20	15
(yellow)	11	10
(light orange)	13	10
(orange)	29	20
(dark orange)	41	30

ADAPTED FROM CANADA GRAINS COUNCIL, 1983.

PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA ENERGY AND NATURAL RESOURCES, 1985.

3.6.3 Impacts On Other Resource Users

Summerfallowing increases the incidence of wind erosion. Bare summerfallowing exposes the soil to wind, whereas natural vegetation or crop residues help shelter soils by reducing wind velocity at the soil surface and preventing drifting. One of the most significant benefits is an improvement in soil conservation. In 1985, between 0.8 million and one million acres of cropped land in the Brown and Dark Brown soil zones were believed to have been affected by wind erosion. This area represents approximately 10 per cent of the total cultivated acreage in those zones. If 10 per cent of the 1.37 million acres brought into annual production were affected by wind erosion, this could mean that an additional 100 000 to 150 000 acres would be provided some protection against wind erosion. In addition, the risk of water erosion, salinization and loss of organic matter will be reduced. This option would also be expected to provide a small benefit for wildlife by increasing cover and food for bird game. No harm to other resource users have been identified in this study.

3.6.4 Farm Financial Effects

The financial analysis investigated several possible crop rotations. In the Brown Soil Zone the reductions investigated were from 1/2 (fallow) - 1/2 (crop) to 1/3 - 2/3; from 1/2 - 1/2 to 1/4 - 3/4; and from 1/3 - 2/3 to 1/4 - 3/4. In the other soil zones the reductions examined were from 1/3 - 2/3 to continuous cropping; from 1/4 - 3/4 to continuous cropping; and from 1/3 - 2/3 to 1/4 - 3/4. A reduction from 1/3 - 2/3 to continuous cropping would mean, for example, that on a 600-acre farm, cropped acreage would increase from 400 to 600 acres annually.

Additional costs and returns, including additional required investment in equipment or earlier replacement of equipment, were investigated and all relevant transfer payments were included. The project analysis

was conducted over nine years, with no residual or increased land value existing at the end of that period. The results of the financial analysis are annual average cash flows and indicate returns to land, labor, management and existing investment (Table 3.6.2).

Summerfallow reduction in the Brown Soil Zone is not financially feasible (with existing practices), while in all other zones it is feasible. Sensitivity analysis showed that summerfallow reduction would remain feasible with fluctuation in yields as experienced over ten years. However, it would not withstand 20 per cent reductions in yields and would be very marginal with 20 per cent reductions in prices. The results were not sensitive to a two per cent increase in the discount rate. In all zones other than the Brown Soil Zone the greatest level of reduction (from 1/3 - 2/3 to continuous cropping) was the most financially attractive. The negative results in the Brown soil zone were a result of the higher input requirements and lower crop yields in that zone. The increased revenues did not offset the additional costs.

As mentioned above, this analysis did not assume changes in farming practices but simply a more intensive cropping system. Summerfallow Reduction with conservation practices may be feasible in the dry Brown Soil Zone, but this was not investigated in this study. With the introduction of conservation farming techniques, this option could be more attractive economically and financially than indicated.

3.6.5 Provincial Economic Results

The economic analysis was conducted parallel to the financial analysis, although transfer payments were excluded and an infinite stream of benefits and costs was assumed. Similar to the financial analysis results, the economic analysis determined that summerfallow reduction in the Brown Soil Zone was not feasible under current management practices. This indicates that both from the individual farmer's perspective and from a provincial economic perspective, the fallow reduction options in that zone are not warranted. Against that conclusion, however, the potential conservation benefits would have to be considered. These

benefits may be warranted despite the reduction in net returns. Nevertheless, the Brown soil zone was not given further consideration in the provincial economic analysis. The potential summerfallow acreage estimate was therefore reduced from 1.37 million to 0.92 million acres for the province.

Table 3.6.2

SUMMERFALLOW REDUCTION, AVERAGE ANNUAL FARM FINANCIAL RETURNS

Soil Zone	Case[1]	Total Resources	After Financing	After Fin. & Tax
			($/acres/year)	
Brown				
	1/2-1/2 vs 1/3-2/3	-1.48	-1.69	-1.35
	1/2-1/2 vs 1/4-3/4	-6.74	-7.02	-6.20
	1/3-2/3 vs 1/4-3/4	-5.26	-5.33	-4.85
Dark Brown				
	1/3-2/3 vs c/c	10.77	10.30	8.24
	1/4-3/4 vs c/c	9.93	9.48	7.59
	1/3-2/3 vs 1/4-3/4	0.83	0.79	0.63
Black (Northeast)				
	1/3-2/3 vs c/c	8.45	8.45	6.76
	1/4-3/4 vs c/c	5.46	5.46	4.37
	1/3-2/3 vs 1/4-3/4	2.99	2.99	2.39
Black (Central)				
	1/3-2/3 vs c/c	12.63	12.63	10.10
	1/4-3/4 vs c/c	11.65	11.65	9.32
	1/3-2/3 vs 1/4-3/4	0.98	0.98	0.78
Gray (Peace River)				
	1/3-2/3 vs c/c	5.58	5.58	4.46
	1/4-3/4 vs c/c	4.25	4.25	3.40
	1/3-2/3 vs 1/4-3/4	1.33	1.33	1.06

1. See text for description of cases.

The direct benefits and costs resulting from removing 0.92 million acres of summerfallow are shown in Table 3.6.3. Since there were no investment requirements other than additional operating equipment, which was treated as a production cost, the value added is equal to the net direct benefits. There were also no lost benefits in other resource sectors.

The results of the provincial value added analysis are shown in Table 3.6.4. No separate on-farm investment is required so the only value added increase comes from the additional agricultural production. As with previous options, the distribution of secondary and total value added benefits is not clearly associated with particular regions. The regional breakdown shown in Table 3.6.3 can, however, be used as an approximate indication of the location of secondary and total provincial value added benefits.

Table 3.6.3

SUMMERFALLOW REDUCTION, DIRECT NET BENEFITS

Soil Zone	Acreage	On-farm Benefit
	(thousand acres)	($ mill., present value)
Gray		
Peace	180	4
Central	30	1
Black	260	14
Dark Brown	460	30
Total	930[1]	48

[1] Excludes 450 thousand acres of potential summerfallow reduction in the Brown Soil Zone.

Table 3.6.4

SUMMERFALLOW REDUCTION, VALUE ADDED RESULTS

Benefits Gained	Direct Value Added	Secondary Value Added	Total Value Added
	($ million, present value)		
Agricultural Output	48	16	64
Value Added Change	48	16	64

3.6.6 Summary of Summerfallow Reduction Results

Potential Scale	
Potential Acreage for Development	930 thousand acres[1]
Annual Agricultural Production Potential	$137 million ($100 per acre)
Annual Farm Financial Returns	$4 to $10 per acre
Economic Results (Present Value)	
Gross Revenue	$208 million
less operating costs	160
On-Farm Value Added	$ 48
less on-farm investment costs	0
On-Farm Net Benefit	$ 48
less public investment costs	0
lost benefits	0
Net Direct Benefits	$ 48 million ($51 per acre)
Growth in Provincial Economy (Present Value)	
Direct Value Added	$ 48 million
Secondary Value Added	16
Total Value Added Change	$ 64 million ($69 per acre)

Potential Significant Impacts:

Positive: Soil conservation

[1] An additional reduction of 450 thousand acres in the Brown Soil Zone was found to be uneconomic, and is therefore not included in the financial and economic results.

3.7 Range Improvement

3.7.1 General Description

The rangelands of Alberta have played a major role in maintaining beef cattle herds. The substantial growth in cattle numbers since the 1950s and increased cost of feed grains has resulted in an increased demand for grazing. Range improvement through seeding of more productive tame species offers ranchers an opportunity to increase production without expanding their land base. Only Canada Land Inventory class 5 lands in the White Area are considered in this option. These lands are defined as having very severe limitations to produce a range of crops, but capable of producing perennial forage crops and suitable for various land improvement practices. Range improvement involves breaking and seeding prairie range to tame pasture; and clearing, breaking, seeding, fencing and fertilizing of woodland range to tame pasture.

Native range was separated into two major vegetative zones: prairie range in Southern Alberta and woodland range found in Central and Northern Alberta. The line between these represents the gradual transition between the short, mixed and fescue grasslands of the prairie range and the parkland and boreal forests of the woodland range. Prairie range was subsequently defined as the Brown and Dark Brown and the southern portion of the Black soil zone. The woodland range area was defined as the remainder of the Black soil zone and all of the Gray soil zone (Central and Peace River areas). These are illustrated in the Percentage of Total CLI Class 5 Lands Available For Range Improvement map.

3.7.2 Agriculture Inventory

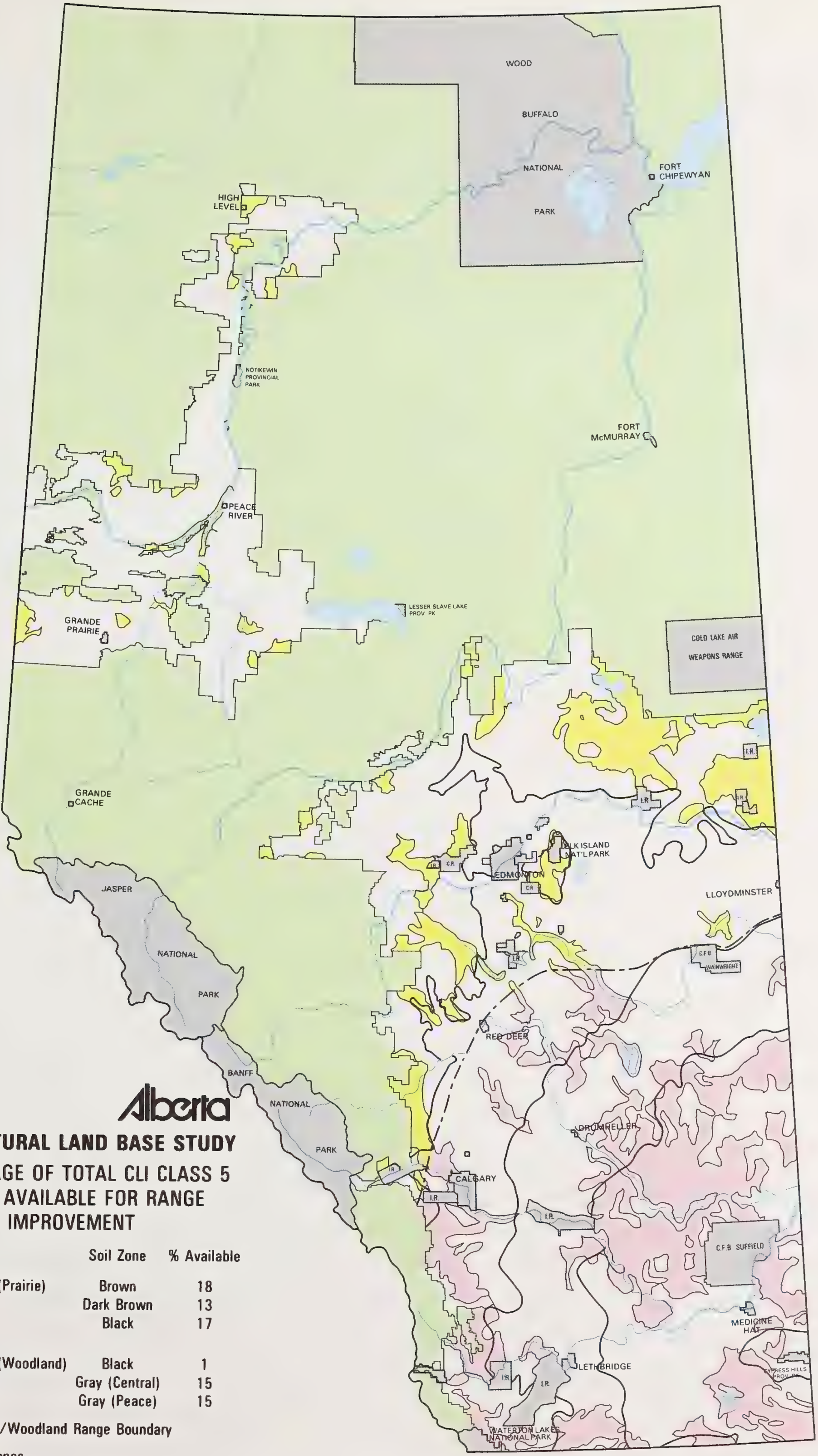
There are 11 million acres of CLI class 5 lands distributed throughout the White Area. The acreage suitable for range improvement was calculated from the total CLI Class 5 acreage less the acreage of currently improved pasture, reported in the 1981 Census of Agriculture. CLI class 5 lands which have other physical limitations such as salinity, acidity and solonetzic hardpan have also been deleted. The acreage was further decreased using development potential estimates from the Public Lands Division, Alberta Forestry, Lands and Wildlife. The map shows the distribution of all CLI class 5 lands and presents a statistical indication of those suitable for improvement. Table 3.7.1 shows this estimated potential for rangeland improvement.

Table 3.7.1

RANGE IMPROVEMENT, POTENTIAL ACREAGE

Prairie Range	(million acres)	Woodland Range	(million acres)
Brown	0.76	Black	0.013
Dark Brown	0.13	Gray	
		- Central	0.26
Black	0.15		
		- Peace	0.10
Total	1.04	Total	0.37

Increases in agricultural production are expressed as changes in carrying capacity. Carrying capacity is the maximum sustainable grazing rate and is measured in animal unit months (AUMs). An animal unit is a mature 1 000-pound cow with calf or equivalent, and is based on the consumption of 26 pounds of organic matter per day. The forage required to support one animal unit for a month is an AUM. Five AUMs, for example, would be required to support a cow and calf for a five-month summer grazing season. Carrying capacities on improved and unimproved



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AGRICULTURAL LAND BASE STUDY

PERCENTAGE OF TOTAL CLI CLASS 5 LANDS AVAILABLE FOR RANGE IMPROVEMENT

	Soil Zone	% Available
CLI 5 (Prairie)	Brown	18
	Dark Brown	13
	Black	17
CLI 5 (Woodland)	Black	1
	Gray (Central)	15
	Gray (Peace)	15

– – – Prairie/Woodland Range Boundary

—— Soil Zones

SOURCE: LAND USE BRANCH, ALBERTA AGRICULTURE, 1985.

PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA ENERGY AND NATURAL RESOURCES, 1985.

rangeland are shown in Table 3.7.2. These figures do not reflect the capacities which can be achieved on intensively managed pasture; they apply to general range conditions in each of the soil zones.

Table 3.7.2

RANGE IMPROVEMENT, CARRYING CAPACITIES

Soil Zones	Carrying Capacity on Unimproved Range	Carrying Capacity on Improved Pasture	Increase in Carrying Capacity
	(animal unit months/acre)		
<u>Woodland Range</u>			
Black	0.25	2.0	1.75
Gray - Central	0.20	2.0	1.80
Gray - Peace	0.20	2.0	1.80
<u>Prairie Range</u>			
Brown	0.20	0.40	0.20
Dark Brown	0.35	1.05	0.70
Black	0.50	1.50	1.00

From these figures it is estimated that there is a potential for an increase of 1.1 million AUMs of grazing capacity, or four per cent of total current provincial grazing capacity, through the improvement of CLI class 5 land. Range Improvement would result in a $50 million increase in the gross annual value of livestock production. Approximately two-thirds of this increase would result from woodland range improvement due to the greater potential increase in per acre capacity in leaving an annual production potential from prairie range improvement of $18 million. Provincially, the rate of range improvement has been approximately 115 000 to 135 000 acres per year. This has been divided fairly evenly between Northern and Southern Alberta. The rate of adoption is responsive to the relative prices for crops and livestock and to the general state of the economy.

3.7.3 Impacts On Other Resource Users

The improvement of approximately 1 million acres of prairie range and 0.4 million acres of woodland range could harm wildlife, timber and water resources. The greatest wildlife habitat losses would occur in the Mixed-grass Prairie and the Montane habitat regions, although the total area affected would be relatively small. It was assumed that all these lands, including any increased carrying capacity resulting from range improvement, would be fully used by domestic livestock. This absolute loss of habitat coupled with the importance of these lands as winter habitat for populations within the Green Area result in wildlife declines being disproportionately high relative to the area affected. Regional populations of moose, elk, mule deer and antelope would be reduced but the provincial potential for production of these species would not change significantly.

The potential impact on timber production on community farm woodlots would also be relatively small. Up to 25 per cent of the land in several developed woodlots could be converted to improved range.

There are approximately 1.5 million acres of CLI class 5 public land currently disposed to grazing, while about 20 to 25 per cent of this could be improved. Range Improvement could increase grazing on public land by approximately 224 600 AUMs. This is a 12 per cent increase in the number of AUMs currently on public land. Public lands could contribute approximately 21 per cent of the total provincial increase of 1.07 million AUMs needed.

Range Improvement is not expected to affect water quality in most areas, although woodland range improvement could negatively affect the Lake Wabamun, Cooking Lake and Beaver River areas.

3.7.4 Farm Financial Analysis

In the economic and financial analyses, it was found that woodland range improvement was not a feasible alternative. Therefore, while the Agricultural Inventory and Impacts on Other Resource Users sections (3.7.2 and 3.7.3) described the combined woodland and prairie Range Improvement options, the Farm Financial Analysis and the Provincial Economic Results only examine the prairie Range Improvement sub-option.

The financial analyses were based on a representative feeder operation with 150 acres of range to be improved and more intensively managed. Clearing and development of woodland was assumed to be done over three years and reseeding of prairie range in one year. Both investments were investigated over 20 years. The acre cost of breaking and seeding prairie range is $70 and that for clearing, breaking, seeding, fertilizing and fencing of woodland range is $305 per acre. The purchase and sale of cattle were treated as annual operating cost and revenue. The financial analysis results are annual equivalent (or annual average) cash flows and indicate returns to land, labor, management and existing investment. They also include the residual value of land at the end of the 20 years (Table 3.7.3).

Table 3.7.3

RANGE IMPROVEMENT, AVERAGE ANNUAL FARM FINANCIAL RETURNS

Soil Zone	Total Resources	After Financing	After Fin. and Taxes
		($/acre/year)	
Prairie Range Improvement			
Brown	2.37	0.52	0.86
Dark Brown	17.25	13.25	11.04
Black	25.98	20.69	17.00
Woodland Range Improvement			
Black	0.59	-12.23	-7.84
Gray	2.29	-10.70	-6.62

The financial results clearly show the difference between range improvement in the southern, prairie region and the northern, woodland region. Woodland improvement had a significantly higher capital cost requirement than prairie range improvement: the present value of these investment requirements were $300 and $65 an acre, respectively. The additional returns to woodland range improvement did not support this level of investment.

The prairie range improvement option, with its lower investment cost, was most attractive in the Black Soil Zone where the increase in carrying capacities was greatest. The lower potential increase in carrying capacity in the Brown Soil Zone made prairie range improvement in that area very marginal, once financing costs and taxes were included. The improvement would not be feasible on Brown soils with as little as a 10 per cent decrease in revenue or a 10 percent increase in total costs. In contrast, improvement on Dark Brown and Black soils would remain feasible with a 10 per cent decrease in revenues or a 20 per cent increase in costs. The results were not sensitive to a two per cent increase in the discount rate.

3.7.5 Provincial Economic Results

The economic analysis also determined that woodland range improvement was not feasible. This indicates that from both a farmer's perspective and a provincial economic perspective, Woodland Range Improvement is not warranted given the carrying capacities expected. From a provincial perspective, there would be no economic justification for providing incentives to the farmer to improve financial feasibility. Because of this economic result, the analysis of Woodland Range Improvement was not carried any further in this study.

The direct agricultural benefits and costs which would result from improvement of 1.04 million acres of prairie range are given in Table 3.7.4. While the acreage potential for this option is greatest in the Brown Soil Zone, the net agricultural benefit is the lowest there.

Annual big game hunting benefits which would be lost as a result of improvement of 1.04 million acres of prairie range were estimated to be $4.8 million. This lost benefit was based on the stated willingness to pay for the hunting experience (over actual expenditures), plus the hunting licence fees. When this annual loss was phased in over 50 years, the present value of the lost wildlife benefit was calculated to be $42 million. The provincial direct benefit analysis therefore showed a total agricultural value added of $81 million, less an on-farm investment requirement of $40 million and a lost hunting benefit of $42 million. This gave a net provincial loss of $1 million for prairie range improvement.

The results of the provincial value added analysis are presented in Table 3.7.5. Direct benefits consist of value added increases resulting from increased agricultural production and from increased on-farm investment. Direct losses are reductions in hunting benefits. Secondary benefits associated with each are shown, as are total provincial benefits. The results show that the net provincial benefits are $42 million.

Table 3.7.4

PRAIRIE RANGE IMPROVEMENT, DIRECT NET BENEFITS

Soil Zone	Average	Gross Margin	Investment Cost	On-farm Net Benefit
	(thousand acres)	($ million, present value)		
Black	150	32	6	26
Dark Brown	130	19	5	14
Brown	760	30	29	1
Total	1,040[1]	81	40	41
	Foregone Hunting Benefits			42
	Direct Net Benefits			-1

[1] Excludes 370 thousand acres of Woodland Range Improvement.

Table 3.7.5

PRAIRIE RANGE IMPROVEMENT, VALUE-ADDED RESULTS

	Direct Value Added	Secondary Value Added	Total Value Added
	($ million, present value)		
Benefits Gained			
Agriculture	81	28	109
On-Farm Investment	27	8	35
Total Benefits Gained	108	36	144
Benefits Foregone			
Hunting	87	15	102
Value Added Change	21	21	42

3.7.6 Summary of Prairie Range Improvement Results

Potential Scale	
Potential Acreage for Development	1.0 million acres[1]
Annual Agricultural Production Potential	$ 18 million ($19 per acre)
Annual Farm Financial Returns	$1to $17 per acre
Economic Results (Present Value)	
Gross Revenue	$123 million
less operating costs	42
On-Farm Value Added	$ 81
less on-farm investment costs	40
On-Farm Net Benefit	$ 41
less public investment costs	0
lost hunting benefits	42
Net Direct Benefits	-$ 1 million (-$1 per acre)
Growth in Provincial Economy (Present Value)	
Direct Net Value Added	$ 21 million
Secondary Net Value Added	$ 21
Total Net Value Added	$ 42 million ($45 per acre)
Potential Significant Impacts:	
Negative: Wildlife	

[1] Development of an additional 370 thousand acres of woodland range improvement was found to be uneconomic, and is therefore not included in the financial and economic analyses.

3.8 Prairie Range Conversion

3.8.1 General Description

Rangeland accounts for a significant portion of Alberta's agricultural land base. This land has been extensively used as a grazing resource for domestic livestock. Nevertheless, where the potential exists there has been a continuing trend to convert rangeland for the production of annual cultivated crops. Range conversion is defined as the breaking and seeding of CLI class 1 to 4 prairie rangeland for cultivated cash crops. Suitable areas are shown in the Prairie Range Conversion Potential map. In Alberta, prairie rangeland is found in the southern half of the province in the Brown, Dark Brown and Black Soil Zones.

3.8.2 Agriculture Inventory

The potential area available for conversion from range to crop land was estimated to be the area of CLI class 1 to 4 lands in southern Alberta, less the area reported by the 1981 Census of Agriculture as being cultivated. Cultivated land includes crops, summerfallow and other improved land. Areas excluded from the study were also deducted, as well as a five per cent reduction in the remaining area based on information from the Public Lands Division of Alberta Forestry, Lands and Wildlife, regarding lands which are not physically suitable for agricultural expansion. The estimated acreage available for conversion from rangeland to crop land totalled 3.53 million acres in Southern and Central Alberta as shown in Table 3.8.1.

Table 3.8.1

PRAIRIE RANGE CONVERSION, POTENTIAL ACREAGE

Soil Zones	Area
	(million acres)
Brown	2.00
Dark Brown	0.89
Black	0.64
Total	3.53

While land suitable for conversion from range to crop production was defined as being in CLI Class 1 to 4, it is recognized that most of the available land is predominately Class 4, because the higher quality land is more likely to be already in cultivated crop production. Accordingly, average crop yields for these soil zones were reduced to be representative of the lower productivity associated with CLI Class 4 soils. Table 3.8.2 shows the estimated yields which could be obtained on this land. The value of unimproved grazing on these lands has been deducted to estimate the incremental increase in production resulting from conversion.

Table 3.8.2

PRAIRIE RANGE CONVERSION, ESTIMATED CROP YIELDS

Soil Zone	Wheat	Oats	Barley	Canola	Hay
		(bushels/acre)			(tons/acre)
Black	24.7	44.5	34.5	15.9	1.5
Dark Brown	23.1	42.4	35.9	17.2	1.0
Brown	18.6	29.4	31.1	12.7	0.6

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AGRICULTURAL LAND BASE STUDY

PRAIRIE RANGE CONVERSION POTENTIAL

Unimproved CLI 1-4

Prairie/Woodland Range Boundary

Soil Zones

SOURCE LAND USE BRANCH, ALBERTA AGRICULTURE, 1985.

PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA ENERGY AND NATURAL RESOURCES, 1985.

The conversion of 3.5 million acres of range to crops would considerably increase agricultural production. The estimated gross value of increased annual production is $239 million, most of which would come from increased wheat production. This increase in annual crop production, however, could result in the estimated potential loss of 1.03 million AUMs of unimproved grazing in Southern Alberta, with a gross value of $48 million. The net increase in agricultural production would therefore be $191 million. The rate of conversion of range to crops has been approximately 155 000 acres per year in recent years. This conversion rate has been largely dependent on crop and livestock prices.

3.8.3 Impacts On Other Resource Users

The conversion of 3.5 million acres of range in Southern Alberta would have a significant impact on wildlife, public range lands and soil and conservation. A major, negative impact would occur on the production of antelope, mule deer and white-tailed deer in the southern and central administrative regions as habitat for these species was disrupted. While the total provincial capability to produce these species would only experience a small decline, the regional impact would be significant since a large percentage of the available habitat in these regions would be affected. Prairie Range Conversion would eliminate 38 and 24 percent of all the non-cultivated lands in the Department of Forestry, Lands and Wildlife's Southern and Central Administrative Regions respectively. Equally significant reductions would be registered in the province's remaining grassland habitat regions: Shortgrass Prairie (-28 per cent); Mixed Grass Prairie (-36 per cent) and Fescue Grasslands (-60 per cent). This loss of habitat would reduce the regional and provincial production capability for antelope by 24 percent. Minor impacts on stream flow, increased sediment and nutrient delivery to streams are expected.

Range conversion could potentially remove six per cent of the total public range land (excluding Special Areas) in the White Area, while as many as half of the provincial grazing reserves could be affected.

Grazing losses on public lands represent about 10 per cent of the total potential grazing losses under this option. Perhaps more important would be changes to traditional ranching lifestyle.

The conversion of arable rangelands to field crop production could also seriously increase existing wind and water erosion problems if proper crop residue management practices are not adopted. Many of the lighter soils in the Brown and Dark Brown Soil Zones are susceptible to wind erosion, and removal of grass cover could increase the existing erosion problem in these areas. Approximately 1 million acres, representing 10 per cent of the total cultivated lands in Southern Alberta, were affected by wind erosion in 1985. Applying this 10 per cent ratio to the 3.5 million acres identified for range conversion could increase the area affected by wind erosion by 30 per cent.

3.8.4 Farm Financial Effects

The financial analysis was based on the assumed conversion of 20 per cent of the range land in a typical cattle-grain farm to crops. These rangelands, before conversion, varied from over 700 acres per farm in the Dark Brown Soil Zone to over 1 400 acres per farm in the Brown Soil Zone. The cost of converting native range to annual cropland was $45 per acre. It was assumed that the number of cattle per farm would be reduced following conversion. The financial analysis results, shown in Table 3.8.3, were based on the change in financial returns from both increased crop production and reduced cattle production. These results are given in terms of annual equivalent (or average annual) cash flow and reflect returns to land, labor, management and existing investment. They also include the residual value of land and equipment at the end of the 10 years analysis.

Table 3.8.3 shows that the conversion of range land to crop land is financially feasible. The positive results indicate that this alternative has little risk for the farmer. Even after financing and taxes have been included as costs, the incremental returns to the farmer are approximately $20 per acre or larger.

Table 3.8.3

PRAIRIE RANGE CONVERSION, AVERAGE ANNUAL FARM FINANCIAL RETURNS

	Total Resources	After Financing	After Fin. & Tax
		($/acre/year)	
Brown	36.16	28.45	24.91
Dark Brown	50.26	41.31	35.53
Black	48.45	38.76	33.81

Sensitivity analysis showed that this option would break even with 10 per cent decreases in gross revenue on Brown and Dark Brown soils and could withstand up to 20 per cent reductions on the Black and Gray soils. On all soils, 20 per cent increases in costs or a two per cent increase in the discount rate would still leave the option feasible.

3.8.5 Provincial Economic Effects

The economic analysis also determined that Prairie Range Conversion was feasible. The direct economic benefits and costs at the farm level are shown in Table 3.8.4. The Brown Soil Zone has the largest potential acreage for conversion from range to crop land and the largest net farm economic benefits, but the lowest per acre net benefit.

Annual hunting and trapping benefits lost were estimated to be over $5 million. These benefits were based on the stated willingness to pay for the hunting experience over and above actual expenditures, plus hunting licence fees. The annual loss is equal to the value per day times the reduced number of hunter days. Lost trapping revenues were also included. When these annual losses were phased in over 50 years, as assumed for range conversion, the present value of the lost wildlife benefit was calculated to be $39 million.

Table 3.8.4

PRAIRIE RANGE CONVERSION, DIRECT NET BENEFITS

Soil Zone	Acreage	Gross Margin	Investment Cost	On-farm Net Benefit
	(thousand acres)	($ million, present value)		
Black	640	119	26	94
Dark Brown	890	110	25	85
Brown	2 000	163	34	128
Total	3 530	392	85	307
	Foregone Hunting and Trapping Benefits			39
	Direct Net Benefits			268

The provincial direct benefit analysis showed a total agricultural value added of $392 million, less on-farm investment requirements of $85 million and foregone wildlife benefits of $39 million. This gives a net provincial benefit of $268 million for 3.53 million acres of range conversion.

The results of the provincial value added analysis are presented in Table 3.8.5. Direct benefits consist of value added increases resulting from increased agricultural production and from increased on-farm investment. Direct losses are reduction in hunting and trapping benefits. Secondary benefits associated with each are shown, as are total provincial benefits.

In comparison to the Range Improvement option, Prairie Range Conversion involves over three times the acreage. It produces, however, 12 times the provincial value added benefits with less quantified benefits lost in the wildlife sector. Prairie Range Conversion also involves approximately twice the level of total on-farm investment as compared to Range Improvement.

Table 3.8.5

PRAIRIE RANGE CONVERSION, VALUE-ADDED RESULTS

	Direct Value Added	Secondary Value Added	Total Value Added
	($ million, present value)		
Benefits Gained			
Agriculture	392	136	528
On-farm Investment	58	16	74
Total Benefits Gained	450	152	602
Benefits Lost			
Hunting and Trapping	74	13	87
Value Added Change	376	139	515

3.8.6 Summary of Prairie Range Conversion

Potential Scale

Potential Acreage for Development	3.5 million acres
Annual Agricultural Production Potential	$191 million ($54 per acre)

Annual Farm Financial Returns	$23 to $32 per acre

Economic Results (Present Value)

Gross Revenue	$1 892 million
less operating costs	1 500
On-Farm Value Added	$ 392
less on-farm investment costs	85
On-Farm Net Benefit	$ 307
less public investment costs	0
lost hunting and trapping benefits	39
Net Direct Benefits	$ 268 million ($76 per acre)

Growth in Provincial Economy (Present Value)

Direct Net Value Added	$ 376 million
Secondary Net Value Added	$ 139
Total Net Value Added	$ 515 million ($146 per acre)

Potential Significant Impacts:

Negative: Wildlife, soil conservation

3.9 Woodland Conversion

3.9.1 General Description

Woodlands cover a large portion of Central and Northern Alberta in the Aspen Parkland and Boreal Forest Ecoregions. Some of this tree and brush cover occurs on arable (CLI class 1 to 4) land which is capable of producing cash crops. The conversion of these lands within the province's Green Area was investigated under the Green Area Conversion option. Woodland Conversion, described here, is the clearing, breaking and seeding of CLI class 1 to 4 woodland areas to cultivated cash crops in the White Area. The areas of the province considered for Woodland Conversion are separated by the same transitional line as described in the Range Improvement option. These areas are shown in the Woodland Conversion Potential map.

3.9.2 Agriculture Inventory

There has been a continuing trend to expand agricultural production through the conversion of arable woodland in the White Area to annual crop production. Over the past several years the rate of conversion has been close to 100 000 acres per year. Together with the Prairie Range Conversion the total rate of development of crop land has averaged 250 000 acres a year.

The amount of land suitable for woodland conversion was calculated by subtracting the total improved area, reported in the 1981 Census of Agriculture from the total area of CLI class 1 to 4 land in the White Area north of the prairie/woodland division. A further 15 percent reduction was made on the basis of information from the Public Lands Division, Alberta Forests, Lands, and Wildlife. This reduction factor represents land that is not suitable for agricultural expansion due to local physical landscape conditions, such as fragmentation. Table 3.9.1 shows the estimated acreage available for woodland conversion.

Table 3.9.1

WOODLAND CONVERSION, POTENTIAL ACREAGE

Soil Zone	CLI 1-4	Currently Cultivated	Acres Available
		(million acres)	
Black	10.34	7.82	2.13
Gray -Central	4.89	2.77	1.80
Gray -Peace	7.64	3.95	3.14
Totals	22.87	14.54	7.07

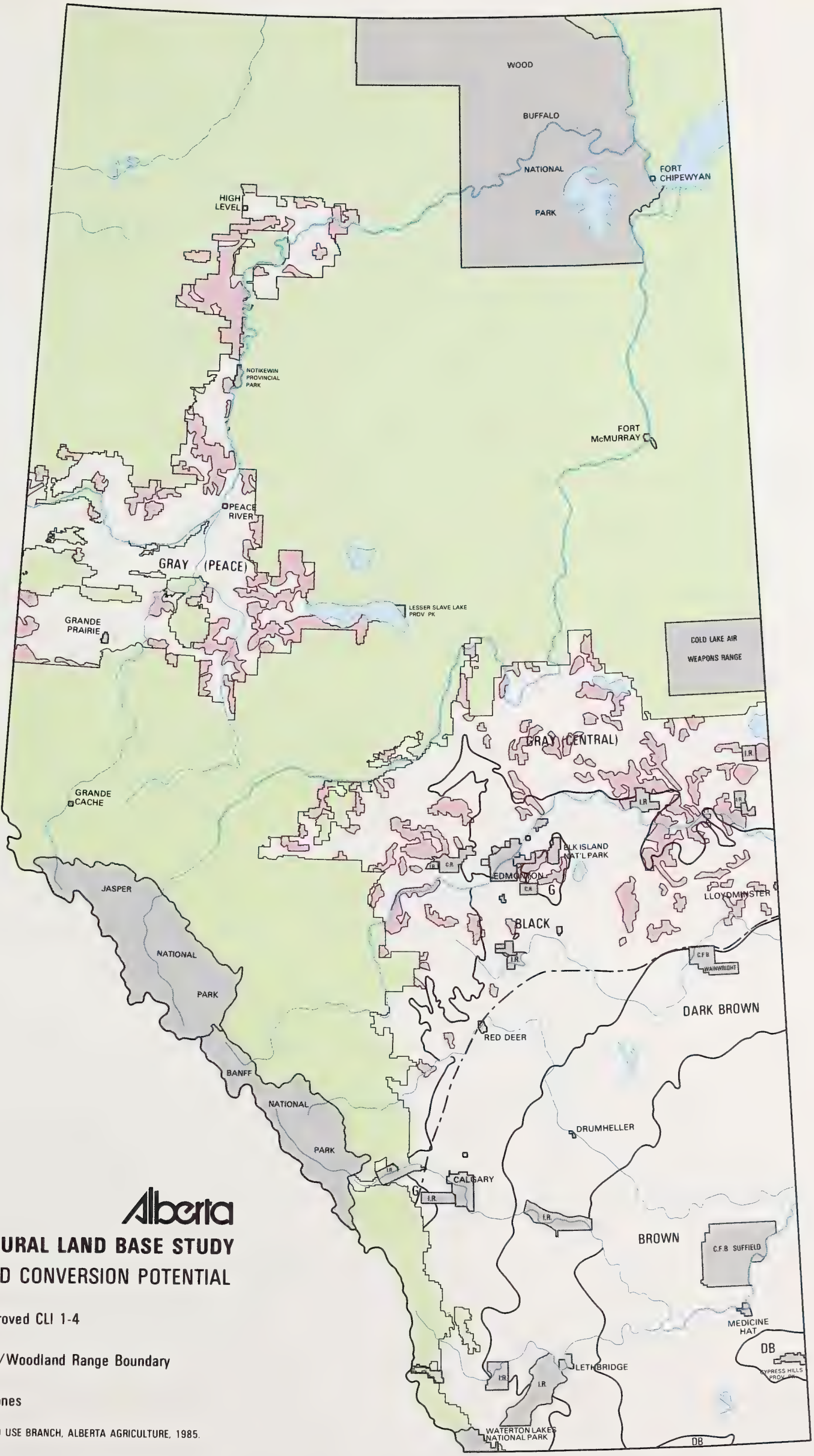
While CLI Class 1-4 lands are considered suitable for woodland conversion, most of the remaining available lands are Class 3 and 4. Potential yields were therefore reduced, and are shown in Table 3.9.2. Previous agricultural uses of these lands were unimproved grazing.

Table 3.9.2

WOODLAND CONVERSION, POTENTIAL YIELDS

Soil Zone	Wheat	Oats	Barley	Canola	Hay
		(bushels/acre)			(tons/acre)
Black	24.7	44.5	34.5	15.9	1.5
Gray -Central	24.6	43.6	31.1	9.6	1.7
Gray -Peace	23.5	43.9	30.3	13.0	1.6

The large potential acreage would produce an estimated annual crop value of $638.5 million after conversion. This increase in cropped acreage could, however, result in an estimated loss of 1.52 million AUMs of grazing, worth approximately $70 million per year. Thus, the final incremental annual value of increased agricultural production is estimated to be $568 million per year.



Alberta

AGRICULTURAL LAND BASE STUDY

WOODLAND CONVERSION POTENTIAL

Unimproved CLI 1-4

Prairie/Woodland Range Boundary

Soil Zones

SOURCE: LAND USE BRANCH, ALBERTA AGRICULTURE, 1985.

PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA ENERGY AND NATURAL RESOURCES, 1985.

3.9.3 Impacts On Other Resource Users

The conversion of close to 7.1 million acres of woodland to crops would have significant impact on wildlife and timber. Soil and water resources may also be affected if proper management is not applied. The clearing of large blocks as well as small residual parcels of unimproved land, could remove almost 30 per cent of the non-cultivated lands in the White Area and 86 per cent of the non-cultivated lands in the Peace River Administration Region. This loss of habitat would substantially reduce the diversity and abundance of wildlife in Central and Northern Alberta. Moose, mule deer and white-tailed deer would suffer the largest potential losses, relative to the provincial production capability. This option would also cause significant losses to upland game birds and it would also create a significant social impact since it would remove much of the area currently most accessible for the viewing and consumptive use of wildlife.

Of the total 7.1 million acres, an estimated 350 000 acres (5%) could be expected to take place on public land. These losses would be more prevalent in the Northeast and Peace River Administration Regions than in other areas of the province. It is anticipated that grazing losses on public lands would represent approximately five per cent of the total potential grazing losses. The impacts on water resources would be similar to those associated with Green Area Conversion. Erosion hazard and water quality problems may become major concerns if large-scale clearing of woodland takes place without proper management and mitiga tion. Both water quality problems and wildlife habitat losses are likely to be significant if large amounts of lake and streambank wooded buffer areas are cleared and cultivated. There would also be less impact on the future use of timber. This lost timber production potential has not been investigated in this study.

3.9.4 Farm Financial Effects

The financial analysis was based on the assumed conversion of 80 acres per farm in the Black Soil Zone, increasing cropped acreage from 600 to 680 acres. In the Gray Soil Zone, cropped acreage per farm was assumed to increase from 600 to 760 acres. It was assumed that there were no quantified agricultural benefits from this land prior to conversion. The cost of clearing, breaking and other preparation work was estimated to be $230 an acre spead over two years on each farm. The financial analysis was for 25 years, and residual land and equipment values at the end of this time were included in the analysis (Table 3.9.3).

Table 3.9.3

WOODLAND CONVERSION, AVERAGE ANNUAL FARM FINANCIAL RETURNS

Soil Zone	Total Resources	After Financing	After Fin. & Tax
		($/acre/year)	
Gray	30.70	25.81	21.82
Black	59.32	56.41	46.49

Woodland Conversion was shown to be financially feasible. The positive results are large enough to indicate that this alternative has little risk for the farmer. Even after financing costs and taxes have been included, the returns to the farmer are greater than $20 per acre. Sensitivity analysis revealed that this option could withstand a 20 per cent decrease in yields or prices, a 20 per cent increase in production costs and remain viable, or a two per cent increase in the discount rate.

3.9.5 Provincial Economic Effects

The economic analysis also determined that the Woodland Conversion was feasible. The direct economic benefits and costs at the farm level are shown in Table 3.9.4. The Peace River Gray Soil Zone had both the largest acreage for conversion and the largest net farm economic benefits.

The provincial direct benefit analysis showed a total agricultural value added of $2 406 million in present value terms. The present value of on-farm investment was $553 million, and that of lost wildlife benefits is $65 million. Annual hunting and trapping benefits which would be lost are estimated to be close to $9 million. When this annual loss was phased in over 50 years, the value of the lost wildlife benefit was calculated to be $65 million in present value terms. This gave a net direct provincial benefit of $1 788 million for the 7.07 million acres.

Table 3.9.4

WOODLAND CONVERSION, DIRECT NET BENEFITS

Soil Zone	Acreage	Gross Margin	Investment Cost	On-farm Net Benefits
	(thousand acres)	($ million, present value)		
Gray				
-Peace	3 140	1 038	167	871
-Central	1 800	870	246	624
Black	2 130	499	141	358
Total	7 070	2 406	553	1 853
	Lost Hunting and Trapping Benefits			65
	Direct Net Benefits			1788

Direct benefits consist of value added increases resulting from increased agricultural production and from increased on-farm investment. Direct losses are reduction in hunting and trapping benefits. Secondary benefits associated with each are shown, as are total provincial benefits in Table 3.9.5. In comparison to the Prairie Range Conversion option, Woodland Conversion involves twice as much land area, more than six times the direct value added in agricultural production and more than six times the total provincial value added.

Table 3.9.5

WOODLAND CONVERSION, VALUE-ADDED RESULTS

	Direct Value Added	Secondary Value Added	Total Value Added
	($ million, present value)		
Benefits Gained			
Agriculture	2 406	836	3 242
On-farm Investment	221	101	322
Total Benefits Gained	2 627	937	3 564
Total Benefits Lost			
Hunting and Trapping	125	22	147
Value Added Change	2 502	915	3 417

3.9.6 Summary of Woodland Conversion Results

Potential Scale	
Potential Acreage for Development	7.1 million acres
Annual Agricultural Production Potential	$568 million ($80 per acre)
Annual Farm Financial Returns	$22 to $46 per acre
Economic Results (Present Value)	
Gross Revenue	$4 915 million
less operating costs	2 509
On-Farm Value Added	$2 406
less on-farm investment costs	553
On-Farm Net Benefit	$1 853
less public investment costs	0
lost hunting benefits	65
Net Direct Benefits	$1 788 million ($253 per acre)
Growth in Provincial Economy (Present Value)	
Direct Net Value Added	$2 502 million
Secondary Net Value Added	$ 915
Total Value Added Change	$3 417 million ($483 per acre)

Potential Significant Impacts:

Negative: Wildlife, soil conservation, water resources, timber production

3.10 Saline Soil Reclamation

3.10.1 General Description

Soil salinity is a major problem on the Canadian prairies, and one which appears to be growing. Saline seepage includes all processes by which soluble salts accumulate at or near the soil surface. Saline seeps occur naturally in many parts of Alberta. However, man's activities have aggravated the problem and have created new areas of salinization. Summerfallowing, irrigation, annual cropping, deforestation and over-grazing all contribute to the increased development of saline seeps.

A number of management practices can be applied to control saline seepage. These include reducing summerfallow acreage, using deep-rooted perennial crops to prevent excessive groundwater recharge, surface and subsurface drainage, and lining irrigation canals to prevent seepage. The selection of appropriate management and reclamation techniques depends on whether the salinity is associated with irrigation or dryland farming. Because the causes, remedies and the financial and economic consequences of these two types of salinity problems are different, they are dealt with in this study as separate options under the general heading of Saline Soil Reclamation.

3.10.2 Agriculture Inventory

The total estimated area affected by saline soils is 3.21 million acres and includes saline conditions ranging from slight to severe. This area includes lands CLI Class 5 and lower as well as lands excluded from the scope of the Agricultural Land Base Study. The total acreage was, therefore, reduced to 2.47 million acres, consisting of 2.22 million acres in dryland farming areas and 250 000 acres in irrigated areas. These area estimates are based on reconnaissance investigation in

selected areas of the province. Dryland Areas Containing Saline Soils and Irrigated Lands Containing Saline Soils maps show areas suitable for Saline Soil Reclamation. Table 3.10.1 shows the distribution of saline acreage between soil zones and irrigation climatic zones.

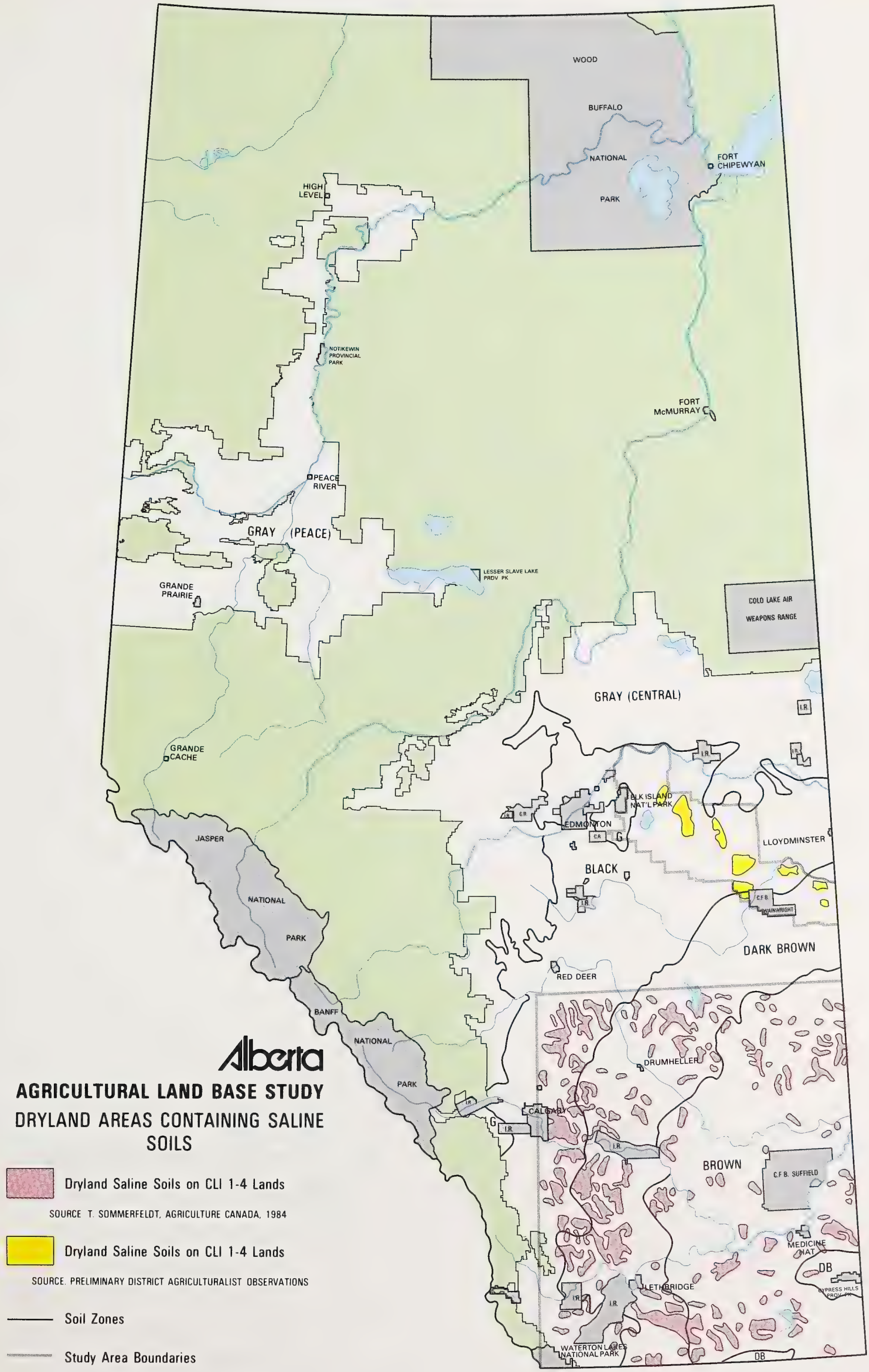
Table 3.10.1

SALINE SOIL RECLAMATION, POTENTIAL ACREAGE

Saline Soils	Area
	(million acres)
Dryland Saline Soils	
Soil Zones	
Black	0.78
Dark Brown	0.69
Brown	0.62
Gray (Central)	0.11
Gray (Peace)	0.02
Total	2.22
Irrigated Saline Soils	
Climatic Zones[1]	
A1	0.05
A2	0.14
B	0.01
C	0.05
Provincial Total	0.25

[1] The Brown soil zone is approximately equivalent to Irrigation Climatic Zones A1 and A2. The Dark Brown soil zone is approximately equivalent to Irrigation Climatic Zones B and C.

The reduced productivity of crops on saline soils is related to both salinity and waterlogging. Soil salinity not only reduces crop production on the land directly affected, but further reduces productivity by isolating non-saline parcels of land and decreasing field efficiences. Slight or moderate salinity also restricts the range of crops which can be grown since crops vary considerably in their salt tolerance. However, research has shown that the productivity of most crops varies according



PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA ENERGY AND NATURAL RESOURCES, 1985.

Alberta

AGRICULTURAL LAND BASE STUDY

IRRIGATED LANDS CONTAINING SALINE SOILS

Current Irrigation

Saline Areas

Irrigation Climatic Zones

SOURCE: T. SOMMERFELDT, AGRICULTURE CANADA, 1984.

PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA ENERGY AND NATURAL RESOURCES, 1985.

to the severity of salinization. Since the level of salinity could not be determined at the scale at which this study was conducted, an average yield reduction of 25 per cent on dryland areas and 50 per cent on irrigated land was assumed.

It was also assumed that, after six or seven years, average yields representative of the region would be achieved for the reclaimed areas. The increase in yield levels for both dryland and irrigated areas is shown in Table 3.10.2.

Table 3.10.2

SALINE SOIL RECLAMATION, INCREMENTAL YIELDS

	Wheat	Oats	Barley	Canola	Hay
Dryland Saline Soils					
		(bushels/acre)			(tons/acre)
Soil Zones					
Black	8.8	15.7	12.2	5.6	0.4
Dark Brown	8.2	15.0	12.7	6.1	0.4
Brown	6.6	10.4	11.0	4.5	0.2
Gray (Central)	8.2	15.4	11.0	4.6	0.4
Gray (Peace)	7.5	13.9	9.6	4.1	0.4
Irrigation Saline Soils					
Irrigation Climatic Zones					
A1	43.2	48.0	48.0	23.1	1.5
A2	42.9	47.9	47.9	24.0	1.5
B	44.7	48.4	48.4	24.0	1.5
C	40.2	47.4	47.4	24.1	1.4

The gross value of additional agricultural production resulting from Saline Soil Reclamation is estimated to be $112 million per year. Of this, $53 million is expected to come from irrigated areas and $59 million from dryland areas. The historic rate of Saline Soil Reclamation including both dryland and irrigated areas, has been less than 2 000 acres per year.

3.10.3 Impacts On Other Resource Users

The only identified impact which the Saline Soil Reclamation would have on other resource users would be the effect of saline subsurface drainage effluent from drainage of irrigated saline soils on the receiving streams and rivers. There is cause for concern regarding the level of dissolved salts which would be carried by these rivers during low flows if maximum subsurface drainage potential is undertaken. The impact on the Oldman River would likely be the greatest since that basin contains most of the saline soils and has significant flow variability. No potential impact on other resource users has been identified.

3.10.4 Farm Financial Effects

The financial analysis of dryland reclamation was based on a representative farm in Warner County (between the Brown and Dark Brown Soil Zones) with 1 110 cultivated acres. Approximately 70 acres were assumed to be severly salinized. The recharge area from which excess groundwater flows to the seep location, was assumed to be 350 acres in size. The reclamation technique used was to plant alfalfa on all 420 acres to reduce groundwater recharge. The benefits achieved included both the new alfalfa production and the reduced cost of farming around the seep areas.

Because information on dryland reclamation was not available for other areas of the province, the financial and economic analyses of this option were restricted to the Brown and Dark Brown soil zones. The acreage of saline soils shown in the following tables is therefore less than that indicated in the general description above.

The irrigated reclamation analysis was conducted by investigating the subsurface drainage of a 25-acre seep on a 160-acre field. Drainage installation costs were $550 an acre and the investigation was done for three representative cases in Southern Alberta (in the Lethbridge Northern, Bow River and Eastern Irrigation districts). More detailed reclamation rates and crop response rates than those reported above were used and the analysis was conducted for differing levels of initial

salinity. The farm financial results are given in terms of annual equivalent (or annual average) cash flow and represent returns to land, labor, management and existing investment (Table 3.10.3). They also include the residual value of land, which is assumed to be equal to the original investment value.

Table 3.10.3

SALINE SOIL RECLAMATION, AVERAGE ANNUAL FARM FINANCIAL RETURNS

	Level of Salinity	Total Resources	After Financing	After Fin. & Tax
			($/acre/year)	
Dryland Saline Soils		22.68	18.50	17.49
Irrigated Saline Soils				
Bow River Irrig. Dist.	High	52.64	43.90	37.47
	Medium	60.34	51.60	39.64
Lethbridge Northern Irrig. Dist.	High	42.96	34.21	29.72
	Medium	49.09	40.34	34.62
Eastern Irrig. Dist.	High	37.92	29.18	25.69
	Medium	44.06	35.32	30.61

These results show that Saline Soil Reclamation is financially feasible, with irrigated saline soil reclamation being somewhat more attractive. All cases examined showed returns to the farmer, after financing costs and taxes had been deducted, of close to $25 an acre up to nearly $40 an acre with an average of approximately $33.

Dryland saline soil reclamation would remain marginally viable, with 10 per cent decreases in prices or yields. Irrigated saline soil reclamation would also remain viable with 10 per cent decreases in revenues and even 20 percent decreases in one case (Bow River Irrigation District, medium salinity). Each irrigated case could withstand 20 percent increases in drainage costs or 20 per cent increases in production costs. Saline Soil Reclamation results were not sensitive to a two per cent increase in the discount rate.

3.10.5 Provincial Economic Results

The economic analysis also determined that Saline Soil Reclamation was feasible. The direct economic benefits and costs at the farm level are shown in Table 3.10.4. Although irrigated saline soils would account for only about 15 percent of the acreage which was analysed for dryland salinity, they would produce more than twice the direct farm benefits, indicating the much higher per acre returns to irrigated reclamation.

Table 3.10.4

SALINE SOIL RECLAMATION, DIRECT NET BENEFITS

	Acreage	Gross Margin	Investment Cost	On-farm Net Benefits
	(thousand acres)	($ million, present value)		
Dryland				
Soil Zones				
Dark Brown	690	38	14	24
Brown	620	34	13	21
Total	1 310	72	27	45
Irrigated				
Irrigation Climatic Zones				
A1	50	30	9	20
A2	140	82	27	56
B	10	6	2	4
C	50	30	9	20
Total	250	147	47	100

The results of the provincial value added analysis are presented in Table 3.10.5. Direct benefits consist of value added increases resulting from increased agricultural production and from increased on-farm investment. No losses of value added occur. Secondary benefits are also shown.

Table 3.10.5

SALINE SOIL RECLAMATION, VALUE ADDED RESULTS

Benefits Gained	Direct Value Added	Secondary Value Added	Total Value Added
	($ million, present value)		
Dryland			
Agriculture	71	25	96
On-farm Investment	15	7	22
Total	86	32	118
Irrigated			
Agriculture	147	51	198
On-farm Investment	19	8	27
Value Added Change	166	59	225

The provincial value added benefits which are gained are not likely to require provincial infrastructure and do not involve quantifiable losses to other sectors such as wildlife. However, the potential negative affects on water quality should be recognized.

3.10.6 Summary of Saline Soil Reclamation Results

Potential Scale	Dryland	Irrigated
Potential Acreage for Development	1.3[1]	0.3 million acres
Annual Agricultural Production Potential	$ 59 ($27 per acre)	$ 53 million ($212 per acre)
Annual Farm Financial Returns	$ 17 per acre	$ 33 per acre
Economic Results (Present Value)		
Gross Revenue	$194	$513 million
less operating costs	123	366
On-Farm Value Added	$ 71	$147
less on-farm investment costs	27	47
On-Farm Net Benefit	$ 44	$100
less public investment costs	0	0
lost benefits	0	0
Net Direct Benefits	$ 44 ($34 per acre)	$100 million ($400 per acre)
Growth in Provincial Economy (Present Value)		
Direct Value Added	$ 86	$166 million
Secondary Value Added	$ 32	59
Total Value Added Change	$118 ($91 per acre)	$225 million ($900 per acre)

Potential Significant Impacts:

Negative: (Irrigated): Water quality
Positive: (Irrigated and dryland): Soil conservation

[1] An additional 0.9 million acres of dryland saline soils in the Black and Gray Soil Zones were excluded from the financial and economic analyses because of a lack of information on reclamation in these areas.

3.11 Government Programs Promoting Agricultural Expansion and Intensification

The Agricultural Land Base Study reviewed existing government mechanisms and activities for assisting agricultural development. Information was collected for each program on the administering agency, the objectives, the nature and size of the program and its relationship to agricultural land expansion and intensification. Programs reviewed were those which directly or indirectly influence the 10 management options evaluated in the Agricultural Land Base Study. Information in the program inventory was current as of March 31, 1986.

3.11.1 Planning and Inventory Programs

1. River Basin and Project Planning for Water Management

   Administered by: Planning Division, Water Resources Management Services, Alberta Environment.

   Objective: To provide the necessary planning for effective water resource co-ordination, development and management.

2. Irrigation Project Planning

   Administered by: Project Planning Branch, Resource Planning Division, Alberta Agriculture.

   Objective: To assist Irrigation Districts and the province plan for the rehabilitation, management and development of irrigation systems to improve water conservation and delivery, and to assist the Irrigation Council's administration of the Irrigation Rehabilitation and Expansion Program.

3. Irrigation Land Classification

Administered by: Land Classification Branch, Resource Planning Division, Alberta Agriculture.

Objective: To provide land evaluation and classification services to facilitate agricultural and irrigated lands allocation, development and conservation, and better soil and on-farm water management practices.

4. Resource Analysis and Planning Services

Administered by: Land Use Branch, Resource Planning Division Alberta Agriculture.

Objective: To collect and analyse data in support of Agriculture's land and water resource use activities, and through participation in resource planning activities, to encourage the allocation, development, management and conservation of these resources for the long-term benefit of the agricultural sector.

5. Resource Economic Analysis and Services

Administered by: Production and Resource Economics Branch, Economic Services Division, Alberta Agriculture.

Objective: To provide resource economic information to policy makers and farmers so that agricultural land and water resources are used in the most economically efficient manner to improve the long-term viability of agriculture, as well as to achieve societal goals.

6. Integrated Resource Planning

Administered by: Resource Planning Branch, Resource Evaluation and Planning Division, Alberta Forestry, Lands and Wildlife.

Objective: To optimize use of the provincial publicly owned lands and minerals resource base and achieve maximum benefits for Albertans now and in the future.

7. <u>Climate Inventory Program</u>

Administered by: Resource Evaluation Branch, Resource Evaluation and Planning Division, Alberta Forestry, Lands and Wildlife.

Objective: To monitor and evaluate agroclimatic resources in the agricultural fringes of the Peace River region.

8. <u>Forage Inventory Program</u>

Administered by: Resource Evaluation Branch, Resource Evaluation and Planning Division, Alberta Forestry, Lands and Wildlife.

Objective: To develop an information base that provides the opportunity for analysis of domestic and wildlife forage potentials on public land.

9. <u>Ecological Land Classification</u>

Administered by: Resource Evaluation Branch, Resource Evaluation and Planning Division, Alberta Forestry, Lands and Wildlife.

Objective: To provide a comprehensive inventory and evaluation of natural resources in Integrated Resource Planning Areas.

10. <u>Soil Survey (Alberta Research Council)</u>

Administered by: Alberta Research Council, Terrain Sciences Dept.

Objective: To generate high quality soils information for government, private industry and individual citizens.

11. <u>Soil Survey (Agriculture Canada)</u>

Administered by: Alberta Pedology Unit (Soil Survey), Agriculture Canada.

Objective: To resurvey selected areas of Alberta and extend soil survey coverage to new areas with a potential for agriculture or other developments, and to improve the quality and consistence of soil classification, mapping, correlation and interpretation.

3.11.2 Water Management Programs

12. Irrigation Headworks and Main Irrigation Systems Improvement

Administered by: Design and Construction Division, Water Resources Management Services, Alberta Environment.

Objective: To expand Alberta's water resource and irrigation development program in Southern Alberta as part of the government's commitment to balanced growth throughout the province and to ensure water delivery to irrigation districts and other multi-purpose water users.

13. Major Water Management Projects

Administered by: Design and Construction Division, Water Resources Management Services, Alberta Environment.

Objective: To finance and construct major water management and control projects which provide widespread benefits to a large area of the province.

14. Operation and Maintenance of Irrigation Headworks Systems

Administered by: Irrigation Headworks Branch, Operation and Maintenance Division, Water Resources Management Services, Alberta Environment.

Objective: To operate and maintain the provincially-owned irrigation headworks systems which directly serve irrigation districts and other water users in southern Alberta.

15. Water Rights Licensing (Consumptive Use)

Administered by: Surface Water Rights Branch, Ground Water Rights Branch, Water Resources Administration Division, Water Resources Management Services, Alberta Environment.

Objective: To review applications and, if approved, grant licences to divert and use surface water and groundwater with the intent of protecting the source of supply and the rights of other users.

16. Water Rights Licensing (Non-Consumptive Use)

Administered by: Regional Services Branch, Water Resources Administration Division, Water Resources Management Services, Alberta Environment.

Objective: To review applications and provide approvals under the Water Resources Act for projects such as: drainage channel realignment and improvement, stream crossings (pipeline, bridges), boat launches and erosion protection works. Approvals are also issued for temporary water uses (oilwell drilling, emergency water supplies).

17. Drainage Districts Administration

Administered by: Administrative Support Branch, Water Resources Administration Division, Water Resources Management Services, Alberta Environment.

Objective: To administer the Drainage Districts Act and to advise each Drainage District Board of Trustees on the conduct of its affairs.

18. Operation and Maintenance of Provincial Water Management Projects

Administered by: Projects Management Branch, Operation and Maintenance Division, Water Resources Management Services Alberta Environment.

Objective: To operate and maintain the provincially owned water management projects throughout the province.

19. Operation and Maintenance of the Sheerness and Deadfish Water Supply Systems

Administered by: Special Projects, Operation and Maintenance Division, Alberta Environment.

Objective: To operate and maintain the provincially owned pumps, canals, reservoirs, and natural channels which supply water from the Red Deer River for irrigation and domestic use along the Berry, Deadfish and Bullpound Creeks in the Special Areas.

3.11.3 Public Land Management Programs

20. Grazing Reserve Development, Heritage Savings Trust Fund

    Administered by: Land Management and Development Branch, Public Lands Division, Alberta Forestry, Lands and Wildlife.

    Objective: To expand or develop new grazing reserves in the gray wooded soil zones of Central and Northern Alberta.

21. Provincial Grazing Reserves Program

    Administered by: Land Management and Development Branch, Public Lands Division, Alberta Forestry, Lands and Wildlife.

    Objective: To provide affordable summer pasture for the livestock of small, beginning farmers and ranchers. To accommodate other land uses including recreational opportunities.

22. Public Land Dispositions

    Administered by: Public Lands Dispositions Branch, Public Lands Division, Alberta Forestry, Lands and Wildlife.

    Objective: To issue and administer dispositions on public lands for agriculture and other uses.

23. Forest Range Management

    Administered by: Forest Land Use Branch, Alberta Forest Service, Alberta Forestry, Lands and Wildlife.

    Objective: To administer and manage the use of rangelands in the Rocky Mountain Forest Reserve and the Green Area portion of the province. To co-ordinate the range improvement program and the pesticide application program for the indicated area.

24. Buck for Wildlife Program

Administered by: Habitat Branch, Fish and Wildlife Division, Alberta Forestry, Lands and Wildlife.

Objective: To protect, enhance and develop wildlife habitat. Although agricultural expansion and intensification are not primary objectives of the Buck for Wildlife Program funds are provided for fencing and stream crossing projects.

25. Accelerated Land Sales

Administered by: Land Management and Development Branch, Public Lands Division, Alberta Forestry, Lands and Wildlife.

Objective: To increase the supply of suitable public land for agricultural uses.

26. Tax Recovery Land Sales Program

Administered by: Special Areas Board, Alberta Municipal Affairs.

Objective: To provide lessees of tax recovery lands in the Special Areas with tenure by selling such land now under lease.

27. Metis Settlement Programs

Administered by: Metis Development Branch, Alberta Municipal Affairs.

Objective: To expand and intensify agriculture on Metis settlements.

3.11.4 Transportation Infrastructure Programs

28. General Transportation Construction and Maintenance Programs Within Rural Alberta

Administered by: Regional Transportation Division, Alberta Transportation.

Objective: To provide funding for necessary construction and maintenance activities on certain public roads within the province, to ensure the reliable and safe accommodation of all modes of traffic.

29. Roads to New Lands

Administered by: Regional Transportation Division, Alberta Transportation.

Objective: To provide funding for road construction required to service new lands posted for agricultural use by the Department of Forestry, Lands and Wildlife, Public Lands Division.

30. Irrigation Bridges

Administered by: Regional Transportation and Engineering Divisions, Alberta Transportation.

Objective: To provide funding for the reconstruction and repair of structural deficient bridges over irrigation canals and ditches.

3.11.5 Financial Support Programs

(i) Grants and Cost-Sharing

31. Irrigation Rehabilitation and Expansion Program

Administered by: Irrigation Council, Alberta Agriculture.

Objective: To assist irrigation districts in the planning, rehabilitation and expansion of irrigation distribution systems to ensure an efficient, assured supply of water to irrigation farmers.

32. Alberta Water Management and Erosion Control Program (Position Paper #5)

Administered by: Regional Services Branch, Water Resources Administration Division, Water Resources Management Services, Alberta Environment.

Objective: To cost-share with local authorities on water resource management projects from which direct public benefits accrue.

33. Rural Water Development Program

Administered by: Soil and Water Conservation Branch, Prairie Farm Rehabilitation Administration, Government of Canada.

Objectives: To assist financially and technically individuals and rural groups throughout the prairie provinces in the development of dependable water supplies for domestic, stockwatering, municipal and irrigation uses. To encourage a standard for water development projects in the prairie provinces to lessen vulnerability to drought periods.

34. Northwest Alberta Erosion Control Program

Administered by: Regional Services Branch, Water Resources Administration Division, and Projects Management Branch, Operation and Maintenance Division, Water Resources Management Services, Alberta Environment.

Objective: To provide cost-sharing assistance to local authorities in the erosion susceptible areas of the province (northwest Alberta) for the construction of new water control projects, the rehabilitation of existing projects and the operation and maintenance of these projects.

35. Range Improvement Assistance Program

Administered by: Land Management and Development Branch, Public Lands Division, Alberta Forestry, Lands and Wildlife.

Objective: To provide incentive to grazing disposition holders who wish to improve production or utilization of the range resource. Such improvements include clearing, piling, breaking, working down, seeding, fencing, stock trail development, water development and control of brush encroachment.

36. Agricultural Lime Freight Assistance Program (ALFA)

Administered by: Soils Branch, Plant Industry Division, Alberta Agriculture.

Objective: To assist farmers in acid soil areas with the cost of lime or marl transportation and to develop a provincial agricultural lime industry.

37. ADC Range and Soil Improvement Loan Program

Administered by: Alberta Agricultural Development Corporation.

Objective: To increase farm and ranch income by encouraging the development and improvement of land productivity.

38. Agricultural Flood Control Program

Administered by: Community and Rural Services Branch, Alberta Agriculture.

Objective: Joint program with Agricultural Services Branch to control flooding of agricultural lands by beaver.

39. Soil Conservation Area Program (SCAP)

Administered by: Conservation and Development Branch, and Rural Services Branch, Alberta Agriculture.

Objective: To prevent or control soil erosion and soil salinity.

40. Agricultural Service Board Conservation and Development Activities

Administered by: Conservation and Development Branch, and Rural Services Branch, Alberta Agriculture.

Objective: To develop, promote and extend technology in the conservation and development of soil and water resources to prevent and control soil degradation and enhance the productivity and economic viability of agricultural producers.

41. Farmland Development and Reclamation Program (FDRP)

Administered by: Conservation and Development Branch, and Rural Services Branch, Alberta Agriculture.

Objective: To improve the productivity of farmland, to reclaim land affected by nuisance waterbodies and to provide water on farms for domestic, livestock, supplemental irrigation and other purposes.

42. Construction of Dams and Dugouts Programs (Water Development)

Administered by: Special Areas Board, Alberta Municipal Affairs.

Objective: To improve water management and development in the Special Areas for livestock.

43. Regrassing Program

Administered by: Special Areas Board, Alberta Municipal Affairs.

Objective: To increase forage productivity on grazing leases in the Special Areas.

44. Alberta Farm Water Grant Program

Administered by: Municipal Utilities Division, Alberta Utilities.

Objective: To assist farmers and ranchers who are encountering water shortages for domestic and stock-watering purposes.

(ii) Loan Programs

45. ADC Beginning Farmer Loan Program

Administered by: Alberta Agricultural Development Corporation.

Objective: To assist qualified farmers with farm experience and/or adequate education to establish a viable farming operation.

46. ADC Direct Farm Loan Program

Administered by: Alberta Agricultural Development Corporation.

Objective: To assist primary producers in the development and maintenance of viable farming operations (as a lender of last resort).

47. <u>ADC Alberta Farm Development Loan Guarantees</u>

Administered by: Alberta Agricultural Development Corporation and approved lending institutions (Chartered Banks, Treasury Branches, Credit Unions).

Objective: To assist primary producers in maintaining or improving productivity by securing short- and intermediate-term financing from approved lending institutions.

48. <u>ADC Specific Guaranteed Farm-Loan Program</u>

Administered by: Alberta Agricultural Development Corporation.

Objective: To assist primary producers in developing or maintaining viable farms by providing 100 per cent guarantees for financing obtained from approved lenders (Chartered Banks, Treasury Branches and Credit Unions).

49. <u>Farm Credit Corporation</u>

Administered by: Farm Credit Corporation (FCC).

Objective: Provide financial services to enable Canadian farmers to establish, develop and maintain sound farm enterprises through the use of long-term mortgage credit.

3.11.6 Technical Services

50. <u>Farm Irrigation Services</u>

Administered by: Irrigation Branch, Alberta Agriculture.

Objective: To assist in the implementation and maintenance of functional on-farm irrigation systems by providing advisory, planning and design information and services.

51. Land Conservation and Development

Administered by: Conservation and Development Branch, Alberta Agriculture.

Objective: To develop, promote and extend technology in the management and conservation of soil and water resources. This program applies to problem soils and the effective use and control of water, in order to maintain or enhance the productive capability of these resources and increase the economic viability of the agricultural producers.

52. Subsurface Drainage

Administered by: Drainage Branch, Alberta Agriculture.

Objective: To develop and promote methods and technologies to improve and reclaim irrigated and dryland soils where subsurface drainage is appropriate.

53. Farm Surface Water Program

Administered by: Regional Services Branch, Water Resources Administration Division, Water Resources Management Section, Alberta Environment.

Objective: To provide technical assistance to farmers for drainage, flood control, erosion and consolidation of water.

54. Inspection Services Program

Administered by: Regional Services Branch, Water Resources Administration Division, Water Resources Management Services, Alberta Environment.

Objective: To provide advice to individuals, local groups, local authorities and private enterprise concerning any matter related to problems caused by surface water. Also to enforce legislation and to investigate alleged violations under the Water Resources Act.

55. <u>Rural Water Development Program</u>

Administered by: Soils Branch, Earth Sciences Division, Environmental Protection Services, Alberta Environment.

Objective: This program is designed as a service to rural residents to determine the suitability of the soil to retain water at proposed dugout and small dam sites, and to determine the cause of water loss from existing sites.

4. INTERPRETATION AND DISCUSSION

Many perspectives or criteria can be used to compare and evaluate the agricultural development alternatives discussed in the previous chapter. This chapter summarizes the results of this study.

4.1 Agricultural Production Potential

The second objective of the Agricultural Land Base Study is the estimation of the maximum potential increase in agricultural production achievable through each of the 10 management options. Area and production estimates are presented as millions of acres and dollars respectively. Presentation of production estimates by gross annual dollar values standardizes, for comparative purposes, basis differences inherent in the original units of measurement: weight (tons/acre), volume (bushels/acre) and grazing capacity (animal units/month/acre). The total value of production calculations represent a gross dollar estimate based solely on the value of agricultural production realized from full implementation. These calculations do not consider economic efficiencies nor the costs of implementation to the farmer or society.

While the acreages associated with the various development options overlap to some extent, a provincial summary of the Inventory's results are presented in Table 4.1. A total of 33 million acres were identified as being suitable for agricultural expansion or intensification. The total Inventory acreage represents an area equivalent to Alberta's currently improved land base of 30 million acres, as defined by the 1981 Census of Agriculture. Full implementation of the identified acreage would result in a total increase in agricultural production valued at \$2.26 billion annually. The total Inventory production estimates represent a 65 percent increase in Alberta's 1984 Annual Farm Cash Receipts of \$3.9 billion. The derived provincial average value of production per acre, resulting from full implementation of all ten development alternatives, was estimated to equal \$73.

Table 4.1

ESTIMATED INCREASES IN ANNUAL AGRICULTURAL PRODUCTION

Development Alternatives	Annual Value of Production	Area	Annual Value Of Production Per Acre
	($ million)	(million acres)	($/acre)
1. Green Area Conversion	762	9.2	83
2. Irrigation Expansion	306	1.1	278
3. Drainage	241	2.1	114
4. Deep Plowing	83	2.2	37
5. Liming	50	2.6 (2.5)[1]	19
6. Summerfallow Reduction	137	1.4 (0.9)[2]	100
7. Range Improvement	50	1.4 (1.0)[2]	35
8. Prairie Range Conversion	191	3.5	54
9. Woodland Conversion	568	7.1	80
10. Reclamation of Salinized Lands			
- Dryland	59	2.2 (1.3)[1]	27
- Irrigated	53	0.3	212
Total	2 260	33.1	73

1. Figures in brackets excludes acreages for which no economic information was available. Reclamation of Salinized Lands in the Black and Gray Soil Zone and Liming in the Brown Soil Zone.

2. Figures in brackets include only the acreage on which development was economically feasible. Summerfallow Reduction in the Brown Soil Zone, and Woodland Range Improvement are excluded.

Individually, the ten development alternatives represent significant opportunities for increasing agricultural production. Each alternative affects more than 1 million acres and generates a corresponding increase in production valued in excess of $50 million annually. However, individual development alternatives exhibit a wide degree of variability in both acreages available for development and their corresponding potential increases in production. Acreage estimates range from a low of 1.1 million acres for Irrigation Expansion to a high of 9.2 million acres for Green Area Conversion. The average acreage estimate is approximately 3.3 million acres. Production

estimates range from a low of $50 million for Liming Acid Soils and Range Improvement (Prairie and Woodland) to a high of $762 million annually for Green Area Conversion. The average production estimates are valued at $250 million annually. The value of production per acre estimates also show considerable variability; ranging from a low of less than $20 per acre for Prairie Range Improvement and Liming to a high of more than $200 per acre for the Irrigated-Saline Soil Reclamation and Irrigation Expansion.

The total area examined in the Agricultural Inventory is roughly equal in size to Alberta's currently improved land base. However, the resulting production increases from full implementation only represent a two-thirds increase in 1984 Annual Farm Cash Receipts. The proportionately lower increase in the value of agricultural production emphasizes a key difference between those lands identified for future agricultural development and those lands currently in production. More than 100 years of settlement has resulted in extensive development of the province's higher capability agricultural lands. Consequently the productivity of many of the development alternatives examined in the Agricultural Land Base Study are restricted by lower natural soil fertility. It is estimated that 90 percent of the lands identified for agricultural expansion are rated as lower capability CLI class 4 lands. Intensification opportunities, with the exception of the Irrigation related alternatives, result in small incremental increases in production on lands currently devoted to agricultural production.

The results indicate that Alberta's land and water resources should not restrict future growth in the agricultural industry. All ten development alternatives represent significant opportunities for increasing agricultural production across the province. The magnitude of these opportunities indicates a resource of national significance. Alberta is recognized as having one of the last large blocks of undeveloped lands available for future agricultural expansion in Canada.

4.2 Potential Impacts On Other Resources

Large scale agricultural development could significantly affect the use of Alberta's land and water resources by other sectors and the conservation of those resources for future use. The potential impacts from each of the 10 development options in the Agricultural Land Base Study have been identified and described. Major impacts would be expected on wildlife and timber. Major impacts could also occur on soil and water resources if mitigation is not implemented. Relatively minor impacts could occur on public rangeland and recreation. These potential impacts are summarized in Table 4.2.1.

Non-agricultural or unimproved agricultural land is extremely important to the maintenance and management wildlife resources. Any alternative that reduces or alters this land base reduces the diversity and abundance of wildlife. Most of the prairie and aspen parkland of Southern and Central Alberta has been allocated to agriculture. Therefore, the alternatives that affect the remainder of these landscapes (i.e. Prairie Range Conversion, Woodland Conversion, Drainage and Irrigation Expansion) have particularly important consequences.

Green Area Conversion and Woodland Conversion, the two options which affect the forested area, involve very large areas of land and would therefore have significant impacts on wildlife. Under Green Area Conversion, for example, almost one-quarter of the province's moose population would be lost and almost 40 percent of the best moose habitat in the province would be destroyed. Woodland Conversion would take both large blocks of unimproved woodland and most importantly, smaller residual woodlands in the Aspen Parkland. This would leave the settled central portion of the province essentially devoid of many wildlife species. Most notably, about 28 percent of the province's white-tailed deer population and about 45 percent of the best wildlife habitat in the province would be lost. Range Conversion would remove large portions of the relatively scarce native grassland remaining in the Shortgrass, Mixedgrass, Fescue Grassland and Aspen Parkland ecoregions.

Table 4.2
POTENTIALLY SIGNIFICANT IMPACTS ON OTHER RESOURCE USERS

	Wildlife Resources	Timber Resources	Public Rangeland Resources	Recreation Resources	Soil Resources	Water Resources
Green Area Conversion	H	H	M	L	H	H
Irrigation Expansion	M	-	L	L	M	H
Drainage	H	-	-	-	L	H
Deep Plowing	-	-	-	-	-	-
Liming	-	-	-	-	-	-
Summerfallow Reduction	L(+)	-	-	-	M(+)	-
Range Improvement	M	L	L(+)	-	-	L
Prairie Range Conversion	H	-	L	-	H	M
Woodland Conversion	H	M	L	-	H	H
Saline Soil Reclamation	L	-	-	-	M(+)	M

H - High Impact
M - Medium Impact
L - Low Impact
(+ = positive impact)

Drainage would greatly reduce the diversity of wetland and upland habitat types available to a great many species in current agricultural areas. Irrigation Expansion and Range Improvement would have a moderate impact on wildlife in the grassland of Southern Alberta, although a large variety of species would be affected and the regional consequences would be important. Wildlife reductions resulting from Prairie Range Improvement would be high relative to the area affected as larger regional populations, primarily elk, are dependent upon these lands for winter habitat. Summerfallow Reduction would have beneficial consequences by providing increased forage and cover for wildlife.

The major impact on timber resources would occur from the Green Area Conversion alternative. The most serious loss of production would be in the Footner Lake, Grande Prairie, Slave Lake and Whitecourt areas. In these areas 10 to 25 per cent of coniferous area and volume and 25 to 45 per cent of deciduous area and volume could be lost due to agricultural expansion.

The Irrigation Expansion, Prairie Range Conversion and Woodland Conversion alternatives would each affect less than 10 per cent of current grazing on public land. Local effects of these losses could be very important, and perhaps most importantly, traditional ranching lifestyles could be affected. Range Improvement could result in a gain of 225 000 AUMs of grazing.

The only recreation resource uses considered in the study were forest recreation areas in the Green Area and water-based recreation in the White Area. It was determined that direct effects of Green Area Conversion would be low on recreation uses. Irrigation Expansion could have a negative affect on wildlife related recreation but would increase water-based recreation. Indirect consequences of the development alternatives have not been documented.

The conversion of non-agricultural or unimproved land to crops could lead to serious impacts for the province's soil resources. Soil salinity is major problem in southern Alberta and good water management and soil conservation measures would be required to prevent its spread under Irrigation Expansion. Soil erosion by wind can also be an important problem, especially in Southern Alberta, but Summerfallow Reduction could play a useful role in reducing this risk.

The impacts of agricultural development on water resources are related to the effects of land clearing and drainage on soil erosion rates and water quality and quantity in Alberta lakes and rivers. Alternatives such as Green Area Conversion, Drainage and Woodland Conversion would produce the greatest impacts since they involve clearing and cultivating forested and wetlands, many of which are very susceptible

to erosion or are poorly drained. Problems such as sediment and nutrient loading and changes in runoff rates would develop and lead to deteriorating water quality and the possibility of flooding or extreme low flows in local streams if adequate mitigation and conservation measures were not undertaken.

It is apparent that, at the provincial level, the potential exists for major impacts on other resources if alternatives such as Green Area Conversion, Irrigation Expansion, Woodland Conversion and Range Conversion are pursued. Mitigation and conservation measures could offset the impacts on soil and water resources and to some extent those on wildlife resources. Deep Plowing, Liming Soils and Summerfallow Reduction would produce no impacts while Range Improvement and the Reclamation of Saline Soils would produce lesser impacts on a small area of the land base.

4.3 Farm Financial Summary

To a farmer, profitability is an important indicator of the feasibility of resource development alternatives. Both the viability and stability of farming can be pursued by identifying those alternatives which provide good financial returns. Those which are financially marginal involve higher risks and would be unattractive if yields, costs, prices or other factors were less favorable than those assumed in the analyses.

Of the various indicators of financial feasibility developed in the Agricultural Land Base Study, two are particularly important. Firstly, the average annual financial return on a per acre basis is a good indicator of the profitability of investment. Farmers with higher costs for each unit of production will be more financially vulnerable, while those with equity in the required investment or better than average management skills will be more secure than the results indicate. For example, with zero equity, Green Area Conversion was not financially feasible. With 30 per cent equity the farmer would cover cash costs and interest payments. The results in this section represent financial returns to land, labor, management and existing investment.

Another indicator of financial feasibility or attractiveness is the required level of on-farm investment. Those alternatives with high investment requirements will usually involve borrowing capital, making the farmer more vulnerable to interest rate changes, declining commodity prices and rising costs. Green Area Conversion, involving both high investment requirements per farm and, often, new farmers with minimal equity, presents a combination that is particularly risky.

Financial results for each of the alternatives investigated are shown in Table 4.3.1. The range of values under many of the options reflect the financial results in different soil zones, irrigation climatic zones or river basins, reflecting differing yields and crop mix in these areas. All financial analyses were based on specific time frames or project life periods. To compensate for this fact, the residual land values at the end of the analysis period (i.e. residual benefits capitalized into the land) were included.

On-farm investment costs, shown in table 4.3.1, are discounted over the period of investment for an individual farm. These investment costs differ from those shown in Table 4.4.2, where discounting takes place over the 50 to 100 years required for implementation of the total potential acreage.

The strongest alternative from a farm financial perspective was Irrigation Expansion. The highest financial returns to irrigation development were associated with Irrigation-Climatic Zones A1 and A2 and with irrigation intensification within or adjacent to existing irrigated areas. The Reclamation of Irrigated Saline Soils also showed good financial returns. Both Irrigation Expansion and the Reclamation of Irrigated Saline Soils had high on-farm capital investment requirements ($367-$523 per acre). Irrigation Expansion is a major undertaking for a farmer and can be risky, despite the strong annual cash flow benefits. Reclamation of Irrigated Saline Soils is less risky because smaller acreages are typically involved.

At the opposite end was the Green Area Conversion alternative. It was clearly shown to be infeasible from a financial perspective, unless a significant amount of farmer equity is brought into the development of new farms and living expenses and periods of low cash flow are covered by an off-farm income. Even if these requirements are met, management ability must be high to achieve good yields and to cope with the high risk associated with the investment of over $300 per acre.

Table 4.3.1

FINANCIAL RESULTS

	Annual Cash Flow	On-Farm Investment
	($/acre)	($/acre, present value)
1. Green Area Conversion	-18	344
2. Irrigation Expansion	26 to 129	367-476
3. Drainage	16 to 45	451-618
4. Deep Plowing	15 to 38	93
5. Liming	9 to 10	54
6. Summerfallow Reduction	-1 to 10	0
7. Range Improvement		
- Prairie	1 to 17	65
- Woodland	-7 to -8	
8. Prairie Range Conversion	25 to 36	52-173
9. Woodland Conversion	22 to 46	214
10. Saline Soil Reclamation		
- Dryland	17	63
- Irrigated	33	523

Liming, Prairie Range Improvement, Dryland Saline Soil Reclamation, and Summerfallow Reduction showed lower financial returns. However, they involved low per acre investment requirements and therefore lower risks than some of the other alternatives.

In recent years approximately 20 000 acres of new lands were withdrawn annually from the Green Area for agricultural development. This implies that despite the negative financial picture of this study, there are other incentives which produce the demand for land and the willingness of individuals to undertake this type of venture. These incentives may include the lifestyle, the challenge and other non-quantifiable factors associated with frontier farming. Also, individual farms are developed at a slower rate than that assumed in this study and with farmer equity in the investment. Total debt is therefore often at a lower level than assumed, reducing the need for off-farm sources of income.

Irrigation Expansion has occurred at the rate of approximately 20 000 acres a year within recent years. This rate is a reflection of the availability of water for irrigation through the provision of publicly funded infrastructure as well as the relatively attractive on-farm feasibility and farmers' willingness to invest in irrigation equipment.

The rates of implementing some development alternatives are quite minimal relative to the acreage identified as having potential for these improvements. Less than 500 acres of land are Deep Plowed each year (2 000 to 5 000 having been plowed to date) and less than 5 000 acres are limed annually. Also less than 1 000 or 2 000 acres of Saline Soils have been reclaimed annually in recent years. The low rates of implementation associated with Deep Plowing, Liming and Saline Soil Reclamation could be the result of many factors. Each of these alternatives were shown to be financially feasible, given the assumptions used in the study. They each involve soil improvement processes rather than direct development. These methods of improvement are not well understood or accepted. In the case of Irrigated Saline Soil Reclamation there is also a high cost and associated high financial risk.

Other alternatives are undertaken at rates above those assumed in this study. The rate of Summerfallow Reduction has been approximately 150 000 to 200 000 acres per year in recent years. The rate of Range Improvement has been 115 000 to 135 000 acres per year over the past several years, while the rate of Range Conversion to cropland has been approximately 155 000 acres per year in recent years. The rate of Woodland Conversion (100 000 acres per year) has been about 70 per cent of that assumed in the study. The range of financial returns for these alternatives is quite wide, with some less than $5 per acre per year. The technology and results of clearing and breaking operations are well known and therefore more readily accepted. While risks to success exist for these alternatives, as for others, there is a perception that these alternatives are either more profitable or less financially risky than others.

4.4 Provincial Economic Summary

Much of the provincial economic information produced in this study on the various agricultural development options is summarized in Table 4.4.1. The results reflect both the land areas involved and the public and private costs and benefits.

The Direct Agricultural Value Added figures indicate the benefits for the farm sector. Direct agricultural value added is equal to the increased revenue resulting from increased agricultural production, less the associated operating costs. Land, labor and return on investment are not charged as costs in this analysis. The agricultural value added therefore reflects returns to these factors as well as management. Also, since these are economic and not financial results, transfer payments such as taxes, subsidies and interest payments are not included. A portion of the agricultural value added would therefore accrue to creditors and governments as recipients of interest and taxes. The agricultural value added is greatest for Woodland Conversion, Green Area Conversion, Drainage, Irrigation Expansion and Deep Plowing of Solonetzic Soils. All options produce a positive agricultural value added.

Table 4.4.1 shows the wide range in Total Investment required by the development options, from $1.78 billion for maximum Irrigation Expansion to no investment requirement for Summerfallow Reduction. Irrigation Expansion and Green Area Conversion have significantly larger investment requirements than any of the other options, though Woodland Conversion and Drainage would also require over $500 million in present value terms. The private investment requirements are highest for Green Area Conversion and Woodland Conversion because of the large acreages involved. Another factor in the Green Area Conversion option is the fact that new farm units are being established. Since investment requirements are often an "up front" cost and because higher private investment usually means higher financing requirements and resulting risk, investment requirement is an important criterion for evaluating these agricultural development options. Public investment requirements, which only apply to the Green Area Conversion, Irrigation Expansion and Drainage options, are shown separately.

Table 4.4.1
SUMMARY OF PROVINCIAL FINDINGS, ECONOMIC RESULTS ON A TOTAL AREA BASIS

Development Alternative	(1) Acreage	(2) Direct Agricultural Value Added	(3) Total Investment	(4) Direct Net Benefit Lost	(5) Direct Net Benefit	(6) Provincial Value Added
	(million acres)	($ million, present value)				
Major Infrastructure Options						
1. Green Area Conversion	9.2	1 758	1 520 (531)[1]	1 054	-816[3]	-1 941[3]
2. Irrigation Expansion	1.1	639	1 783 (1 647)[1]	6	-1 150[2]	1 934[2]
3. Drainage	2.1	739	702 (373)[1]	14	23	1 366
Direct Development Options						
1. Deep Plowing Solonetzic Soil	2.2	568	146	0	422	695
2. Liming Acid Soils	2.5	219	95	0	124	294
3. Summerfallow Reduction	0.9	48	0	0	48	64
4. Prairie Range Improvement	1.0	81	40	42	-1	42
5. Prairie Range Conversion	3.5	392	85	39	268	515
6. Woodland Conversion	7.1	2 406	553	65	1 788	3 417
7. Reclamation of Saline Soils						
- Dryland	1.3	71	27	0	44	118
- Irrigated	0.3	147	47	0	100	225

Col. 2: Direct value added in the form of agricultural production.
Col. 4: Includes direct benefits lost from forestry, hunting and trapping.
Col. 5: Col. 2 - Col. 3 - Col. 4 Direct value added in agriculture less total investment and foregone direct benefits.
Col. 6: Direct value added and secondary benefits from agriculture, public and private investment, less value added and secondary benefits foregone from forestry, hunting and trapping.

1. Figures in brackets are the required infrastructure costs, borne primarily by government and are part of the indicated totals.
2. Analysis does not include benefits associated with municipal and industrial water supply, improved water quality, recreation and stabilizing effect for drought prone areas.
3. Analysis does not include benefits associated with transportation and utility infrastructure used by other development, particularly oil and gas.

The Direct Net Benefits Lost in the forestry and wildlife sectors is also shown in Table 4.4.1. The significant loss associated with Green Area Conversion is primarily in the forestry sector; the present value of lost timber revenue is $1.04 billion.

Direct agricultural value added less the total investment costs and foregone benefits, equals the Direct Net Benefit. The two large negative values under that heading are approximately $1 billion each and are associated with Green Area Conversion and Irrigation Expansion. The direct agricultural value added are not sufficient to offset the large investment costs for these alternatives and the large loss in forestry revenue from Green Area Conversion. At the opposite end the direct net benefits from Woodland Conversion are close to $2 billion in present value terms, due to the large total acreage and the absence of large infrastructure investment costs. The direct net benefits for the other options are relatively smaller, with Deep Plowing and Prairie Range Conversion showing fairly good results.

The final column indicates Provincial Value Added, or growth in the provincial economy. These figures include first, the direct agricultural value added from increased agricultural output and investment and second, the secondary benefits which may be created in other parts of the Alberta economy. While the analysis of Direct Net Benefits treats both investment and lost benefits as costs, the provincial value added analysis treats investment as a benefit. Because government and private investment creates new income in other sectors of the economy. Woodland Conversion and Irrigation Expansion are the two alternatives which create the largest provincial value added. In the case of Woodland Conversion, this is primarily due to a large increase in agricultural output, while in the case of Irrigation Expansion, it results from both increased agricultural production and from large investment expenditures for the construction of infrastructure. Green Area Conversion, on the other hand, produces a large loss in provincial value added due to the significant drop in timber production.

While the quantified direct agricultural value added from Irrigation Expansion are less than the investment requirements, this alternative can be supported on the basis of the increased income which it creates throughout the provincial economy. Even without secondary benefits, Irrigation Expansion is attractive from a direct agricultural value added perspective, producing a present value of $1.9 billion. In addition to the economic benefits to other sectors, there are many non-quantified benefits which are expected to result from irrigation expansion. These include an expanded municipal and industrial water supply, improved water quality, water-based recreation and the stabilizing effect of irrigation on the economy of drought-prone areas.

The Green Area Conversion option, in contrast, does not appear to be feasible from either a direct net benefit or provincial value added perspective. This alternative would also create benefits which have not been quantified here, such as the development of transportation and utility services which would benefit other sectors including oil and gas produc-tion and the development of local communities and the regional economy. These non-quantified benefits should be seen as offsetting, to a degree, the negative economic results for Green Area Conversion.

While the total potential benefits and costs associated with the full development of each of the alternatives, this scale of development may be unrealistic, or only a long-run possibility for a number of the alternatives. It is expected that partial development would give results reflective of the per acre values shown in Table 4.4.2. More site specific data and analysis would be required to produce reliable estimates before implementation of any particular project.

On a per acre basis, the ranking of Total Investment requirements changes. Irrigation Expansion requires by far the largest investment, with the public or off-farm portion of this again being much larger than the private or on-farm portion. Current cost-sharing arrangements requires farmers to contribute to the cost of off-farm investment. On a per acre basis, the investment requirements for Green Area Conversion are much lower than for Irrigation Expansion.

The Direct Net Benefits equal the direct agricultural value added less the total investment requirements and direct benefits lost in other sectors. Green Area Conversion and Irrigation Expansion showed negative results, with the latter being much larger. Strong positive results are shown for the Reclamation of Irrigated Saline Soils, Woodland Conversion, and Deep Plowing. None of these latter options require off-farm investment and they all have small or no quantified impacts on other resource sectors.

The Provincial Value Added is also shown on a per acre basis in Table 4.4.2. Irrigation Expansion shows the largest per acre provincial value added, resulting largely from the income generated by private and public investment. Green Area Conversion again shows a negative result, due to losses of forest- related economic activity.

One objective of agricultural resource development is to maximize the returns to investment. Table 4.4.2 shows three indicators of returns to total investment, in ratio form: the ratio of Direct Agricultural Value Added to Total Investment, the ratio of adjusted value added (Direct Agricultural Value Added minus Direct Benefits Lost) to Total Investment, and the ratio of Provincial Value Added (direct plus secondary value added) to Total Investment. Each of these is a useful indicator of returns to investment. All of these ratios show that Woodland Conversion and Prairie Range Conversion have the highest returns to investment, with Deep Plowing and Reclamation of Irrigated Saline Soils also showing fairly strong results. These ratios also show negative or marginal results for Green Area Conversion and Irrigation Expansion.

Table 4.4.2 SUMMARY OF PROVINCIAL FINDINGS, ECONOMIC RESULTS ON A PER ACRE BASIS

Alternative	(1) Acreage	(2) Direct Agric. Value Added	(3) Total Invest.	(4) Direct Benefits Lost	(5) Direct Net Benefits	(6) Provincial Value Added	(7) Ratio of Direct Agric. Value Added to Total Invest.	(8) Ratio of Adjusted Value Added to Total Invest.	(9) Ratio of Provincial Value Added to Total Invest.
	(million acres)			($/acre, present value)					
Major Infrastructure Options									
1. Green Area Conversion	9.2	191	165 (58)[1]	115	-89[2]	-211[2]	1.2	0.5	-1.3
2. Irrigation Expansion	1.1	561	1565 (1446)[1]	10	-1014[3]	1698[3]	0.4	0.4	1.1
3. Drainage	2.1	349[4]	331 (176)[1]	7	11	644	1.1	1.0	1.9
Direct Development Options									
1. Deep Plowing	2.2	256	66	0	190	313	3.9	3.9	4.7
2. Liming	2.5	87	38	0	48	117	2.3	2.3	3.1
3. Summerfallow Reduction (excluding Brown Soil Zone)	0.9	52	0	0	51	69	N/A[5]	N/A[5]	N/A[5]
4. Prairie Range Improvement	1.0	78	38	40	-1	45	2.1	1.0	1.2
5. Prairie Range Conversion	3.5	112	24	11[6]	76	146	4.6	4.2	6.0
6. Woodland Conversion	7.1	340	78	9[6]	253	483	4.4	4.2	6.2
7. Reclamation of Saline Soils									
- Dryland	1.3	55	21	0	34	91	2.6	2.6	4.3
- Irrigated	0.3	588	188	0	400	900	3.1	3.1	4.8

Column 2. Direct value-added from agricultural production (Gross value minus operating costs).
Column 4. Direct benefits lost in timber production, hunting and trapping (Net of all costs).
Column 5. Co. 5 = Co. 2-Col. 3-Col. 4. Direct value-added in agriculture less total investment and foregone direct net benefits.
Column 6. Direct value-added and secondary benefits from agriculture and public and private investment adjusted for value-added and secondary benefits lost from forestry, hunting and trapping.
Column 7. Col. 7 = Col. 2/Col. 3. This is a net B/C ratio (Value added to agriculture per $ investment).
Column 8. Col. 8 = (Col. 2-Col. 4)/Col. 3. This is Col. 7 adjusted for benefits foregone.
Column 9. Col. 9 = Col. 6/Col. 3. This is direct plus secondary value added to the provincial economy (adjusted for value added foregone) per $ invest.
1. Figures in brackets are the required infrastructure costs, borne primarily by government and are part of the indicated totals.
2. Analysis does not include benefits associated with transportation and utility infrastructure used by other development, particularly oil and gas.
3. Analysis does not include benefits associated with municipal and industrial water supply, improved water quality, recreation, and stabilizing effect for drought prone areas.
4. Includes benefits from upland (non-drained) area.
5. Ratio is infinite since investment (Col. 5) is zero.
6. Does not include lost timber production value.

It is important to recognize that the results are averages and that individual projects may be more or less attractive than these results suggest. Further detailed investigation is required on site specific implementation, particularly for those options with high infrastructure costs. The results of the economic analysis are only a part of the information which should be considered in evaluating the various alternatives. Many important positive and negative effects have been omitted from the economic analysis since values for these effects could not be quantified in dollars. These include significant benefits such as water supply and recreational values from Irrigation Expansion and roads and other infrastructure from Green Area Conversion. The negative effects which have been excluded from the economic analysis include wildlife values such as non-consumptive use and possible soil erosion.

4.5 Provincial Summary

Table 4.5.1 presents the major parts of Tables 4.1.1 to 4.3.1 and Table 4.4.2 in a single summary. The major physical production potential, financial and economic, and non-economic impact information is consolidated here for ease of comparison.

The economic information is shown on a per acre basis since this gives a better indication of the expected results under partial development of the full potential acreage for each option. Full development of the potential acreage is unlikely for a long time, or, for some options, may never be achieved.

The information on impacts on other resource users is taken primarily from Table 4.2.1; those impacts which are rated as "high" or "medium" are shown in Table 4.5.1. In addition, potential positive impacts from Green Area Conversion and Irrigation Expansion on such things as infrastructure development for other sectors, soil conservation, and agricultural stabilization are shown. All of the potentially significant impacts are important factors to be considered in conjunction with the economic results.

Table 4.5.1 SUMMARY OF PROVINCIAL RESULTS

	Production Potential			Financial and Economic Potential								Potential Significant Impacts	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	Potential Acreage	Potential Value of Prod.	Average Farm Cash Flow	Direct Agricultural Value Added	Total Investment	Direct Net Benefits Lost	Direct Net Benefit	Prov. Value Added	Ratio of Direct Agric. Val. Added to Total Invest.	Ratio of Adjusted Value Added to Total Invest.	Ratio of Provincial Value Added to Total Invest.	NEGATIVE	POSITIVE
	(mill.ac.)	($ mill./yr.)	($/ac./yr.)	....................($/acre, present value)..............					.............(ratio)...........				
MAJOR INFRASTRUCTURE OPTIONS													
Green Area Conversion	9.2	762	-18	191	165 (58)[5]	115	-89	-211	1.2	0.5	-1.3	Wildlife, timber, rangeland, soil conserv. and water resources	Trans. and utility infrastructure
Irrigation Expansion	1.1	306	26 to 129	561	1 565 (1 446)[5]	10	-1 014	1 698	0.4	0.4	1.1	Wildlife, soil salinity, water quality	Mun. and indust. water supply, soil conserv., agric. stabilization, water based recreation
Drainage	2.1[1]	241	16 to 45	349[4]	331 (176)[5]	7	11	644	1.1	1.0	1.9	Wildlife, water resources	
DIRECT DEVELOPMENT OPTIONS													
Deep Plowing	2.2	83	15 to 38	256	66	0	190	313	3.9	3.9	4.7		
Liming	2.5 (2.6)	50	9 to 10	87	38	0	48	117	2.3	2.3	3.1		
Summerfallow Reduction	0.9 (1.4)[2]	137	4 to 10	52	0	0	51	69	---[6]	---[6]	---[6]		Soil conservation
Prairie Range Impr.	1.0 (1.4)[2]	50	1 to 17	78	38	40	-1	45	2.1	1.0	1.2	Wildlife	
Prairie Range Conv.	3.5	191	25 to 36	112	24	11	76	146	4.6	4.2	6.0	Wildlife, soil conserv. and water resources	
Woodland Conversion	7.1	568	22 to 46	340	78	9[7]	253	483	4.4	4.2	6.2	Wildlife, soil conserv. water resources, & timber product.	
Saline Soil Recl.													
- Dryland	1.3 (2.2)[3]	59	17	55	21	0	34	91	2.6	2.6	4.3		
- Irrigated	0.3	53	33	588	188	0	400	900	3.1	3.1	4.8	Water quality	Soil conservation

Explanation of Columns

Column 2. Based on full development of potential acreage.
Column 4. Direct value-added from agricultural production (Gross value minus operating costs).
Column 6. Direct benefits foregone in timber production, hunting and trapping (Net of all costs).
Column 7. Col. 7 = Col. 4-Col. 5-Col. 6. Direct value-added in agriculture less total investment and foregone direct net benefits.
Column 8. Direct value-added and secondary benefits from agriculture and public and private investment adjusted for value-added and secondary benefits foregone from forestry, hunting and trapping.
Column 9. Col. 9 = Col. 4/Col. 5. This is a net B/C ratio (Value added to agriculture per $ investment).
Column 10. Col. 10 = (Col. 4-Col. 6)/Col. 5. This is Col. 9 adjusted for benefits foregone.
Column 11. Col. 11 = Col. 8/Col. 5. This is direct plus secondary value added to the provincial economy (adjusted for value added foregone) per $ investment.

Footnotes

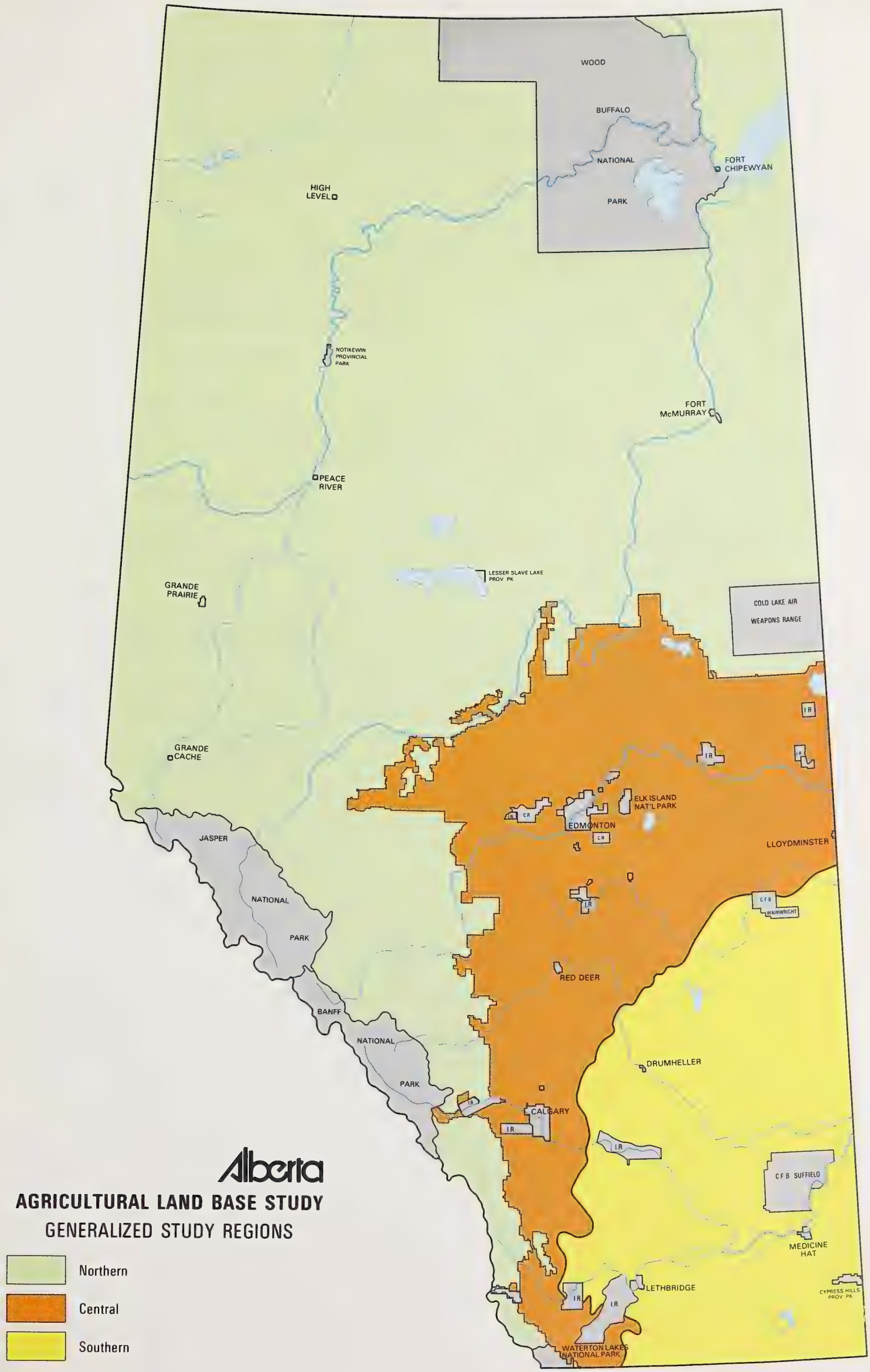
1. There are an additional 2.7 million acres of potentially drainable organic soils. Does not include acreage in the Red Deer River basin or southward.
2. Figures in brackets include acreage on which development was estimated to be economically infeasible, eg.Summerfallow reduction in the Brown Soil Zone, and Woodland Range Improvement.
3. Figure in brackets includes saline acres in the Black and Gray Soil Zone for which no economic information was available.
4. Includes benefits from upland (non-drained) areas.
5. Figures in brackets are required infrastructure, borne primarily by government, and are included in the indicated totals.
6. Ratio is infinite since investment (Col. 5) is zero.
7. Does not include lost timber production value.

4.6 Regional Development Potential

Information on the regional effects of agricultural resource development is important in order to evaluate opportunities. Not only should resource development be efficient in the sense of total benefits exceeding total costs, but the regional economic effects should be considered in establishing a pattern of development.

For the purpose of the Agricultural Land Base Study, the province was divided into three broad regions. The Southern Region consists of the Brown and Dark Brown Soil Zones; the Central Region consists of the Black Soil Zone and the Gray Soils in the central portion of the province; and the Northern Region consists of the Gray Soils in the Peace River Area, including the arable land in the province's Green Area. These are shown in the Generalized Study Regions map. The results of the provincial analyses are presented regionally on the basis of the acreage available for each of the options and the farm financial results. The acreage breakdown is significant in itself and also in the fact that investment requirements and, to a large extent, the impacts of the development on other sectors are directly proportional to developed acreage.

The proportions of developable acreage between regions are shown in Table 4.6.1. Three of the options occur in only one region; Green Area Conversion would affect only Northern Alberta, while Irrigation Expansion and the Reclamation of Irrigated Saline Soils would take place in Southern Alberta only. Dryland Saline Soil Reclamation could affect Central and Northern Alberta, but was assessed for Southern Alberta only because of the limited information available.



Alberta

AGRICULTURAL LAND BASE STUDY

GENERALIZED STUDY REGIONS

PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA FORESTRY, LANDS AND WILDLIFE, 1986.

Table 4.6.1

REGIONAL DISTRIBUTION OF DEVELOPABLE ACREAGE

	Southern	Central	Northern
		(percentage)	
Major Infrastructure Options			
1. Green Area Conversion			100
2. Irrigation Expansion	100		
3. Drainage[1]	12	70	18
Direct Development Options			
1. Deep Plowing	47	53	
2. Liming	9	50	41
3. Summerfallow Reduction[2]	50	31	19
4. Prairie Range Improvement	86	14	
5. Prairie Range Conversion	82	18	
6. Woodland Conversion		56	44
7. Saline Soil Reclamation			
- Dryland[3]	100		
- Irrigated	100		

1. Potential not assessed south of the Battle River Basin.
2. Excluding Brown Soil Zone.
3. Assessed for Brown and Dark Brown Soil Zones only.

Of the total of approximately 31 million acres which could be developed under the ten options examined in this study, approximately 8 million acres are available in Southern Alberta, 9 million acres in Central Alberta, and 14 million in the Northern region. Over 12 million of the 14 million acres in Northern Alberta are available for expanding the agricultural land base through Woodland or Green Area Conversion. In the Central and Southern regions the major potential is for intensifying production under the other options.

Table 4.6.2 shows the regional ranking of farm financial results. The ranges of values shown there indicate farm financial results in different soil zones, irrigation climatic zones or river basins.

Table 4.6.2

REGIONAL SUMMARY, FARM FINANCIAL ANALYSIS

SOUTHERN		CENTRAL		NORTHERN	
Option	Average Annual Farm Cash Flow ($/Ac/Yr)	Option	Average Annual Farm Cash Flow ($/Ac/Yr)	Option	Average Annual Farm Cash Flow ($/Ac/Yr)
1) Irrigation Expansion	26 to 129	1) Woodland Conversion	46	1) Drainage	27
2) Irrigated Saline Soil Reclamation	33	2) Deep Plowing Solonetzic Soils	38	2) Woodland Conversion	22
3) Prairie Range Conversion	25 to 36	3) Drainage	16 to 45	3) Liming Acid Soils	9
4) Dryland Saline Soil Reclamation	17	4) Prairie Range Conversion	34	4) Summerfallow Reduction	4
5) Deep Plowing Solonetzic Soils	15 to 17	5) Prairie Range Improvement	17	5) Green Area Conversion	-18
6) Prairie Range Improvement	1 to 11	6) Liming Acid Soils	10		
7) Liming Acid Soils	9	7) Summerfallow Reduction	4 to 10		
8) Summerfallow Reduction[1]	8				

[1] Dark Brown Soil Zone only.

On the basis of these farm financial results, the most attractive opportunities in each region are:

1. Southern Region: Irrigation Expansion, Irrigated Saline Soil Reclamation
2. Central Region: Woodland Conversion, Deep Plowing, Drainage Prairie Range Conversion
3. Northern Region: Drainage, Woodland Conversion

These results illustrate the regional analysis which will be required to more fully evaluate each of the development opportunities.

5. CONCLUSIONS AND IMPLICATIONS

5.1 Resource Development Policy Issues

The implementation of any of the 10 long-range resource management opportunities must be considered in the context of broad provincial objectives, such as maximizing agricultural production and farm incomes, minimizing impacts on other resource sectors, (including the conservation of soil, water, wildlife and timber resources) and achieving balanced regional development. Programs may need to be supplemented, strengthened or otherwise adjusted to achieve the desired rate and pattern of development. Funding will also be required to bring into effect any of the development opportunities.

It is important to remember that these results are averages and that individual projects may be much more or less attractive than these results suggest. Further detailed investigation is required on site specific implementation, particularly for those options with high infrastructure costs.

A number of resource development policy issues are raised by this study. These must be carefully considered, when formulating action plans.

1. Green Area Conversion significantly reduces timber production and wildlife habitat. Expansion of agricultural production should only be considered after careful identification of those locations where agricultural productivity is high and impacts on the forest industry are low. Conversion would also result in the large-scale displacement of trapping and the loss of prime habitat essential to subsistence hunting. The equity requirements for new farm development in the Green Area are high.

Farm expansion and other means of promoting adequate farmer equity should be considered. Full development of the potential acreage under this option would require large-scale investment in community and regional infrastructure.

2. Irrigation Expansion would create significant benefits through regional economic spinoffs, stabilization of the effects of drought, water supply and recreational benefits. It would produce attractive financial returns to the farmer. The high infrastructure and public investment requirements must, however, be recognized. Limited irrigation expansion may be more advisable than maximum expansion. Those projects which require less infrastructure and are less costly, should be identified.

3. Drainage can produce significant benefits through increased production and reduced farming costs. This could seriously reduce wildlife habitat, and increase downstream flooding and soil erosion. Protection or enhancement of key wildlife habitat and adequate planning and design of drainage works would be required to offset these impacts. Many potential impacts could be eliminated by on-farm water consolidation and management.

4. Deep Plowing, Liming and Irrigated Saline Soil Reclamation show financial and economic benefits which are high relative to the current rates of adoption by farmers. These options also have little or no negative impacts on other resource users. Improved extension or assistance programs may be warranted to increase the rate of adoption.

5. Prairie Range Conversion shows good financial and economic results, though full development of this option would impact cow-calf production and ranching lifestyles.

6. Prairie Range Conversion and Woodland Conversion would reduce wildlife habitat significantly in the settled areas province if these options were undertaken to their full potential. The regional distribution of wildlife populations must be considered.

7. Summerfallow Reduction is an important objective with respect to soil conservation. Canadian Wheat Board quota policy and farmer awareness of the benefits of reduced summerfallow need to be addressed.

8. Green Area Conversion, Irrigation Expansion, Drainage, Prairie Range Improvement, Prairie Range Conversion and Woodland Conversion require careful conservation management in order to control soil erosion and reduced water quality. Options such as Deep Plowing, Liming, Summerfallow Reduction and Saline Soil Reclamation would benefit soil conservation.

5.2 Conclusions

Alberta's 1982 improved farmland base of 30 million acres generated $3.8 billion in annual farm cash receipts. This study has shown that an expansion of the agricultural land base by over 22 million acres (Green Area Conversion, Drainage, Prairie Range and Woodland Conversion) and an intensification of production on close to 11 million acres could increase agricultural production by $2.5 billion annually.

Several of the development opportunities require considerable public and private investment and would negatively impact other resource sectors. While the size of benefits and costs may change over time, as commodity prices and input costs vary, it is expected that their ranking under the various criteria used in this study will remain constant.

This study has produced a large amount of data on the potential for agricultural development in Alberta. The maps contribute to our understanding of the extent and location of each development opportunity. The study's most valuable contribution is the broad perspective from which to evaluate and compare the major agricultural development opportunities.

A number of steps are required before the development options described in this study can be implemented. Further work is required to identify the prime locations for each option and to refine the financial and economic results from a regional perspective. An important part of this investigation will be to examine the feasibility of partial development. The results presented are averages and individual projects may be more or less attractive than these results suggest.

Impact mitigation and resource conservation must be considered when seeking to maximize benefits from our land and water resources. Programs which affect development may need to be supplemented, strengthened or otherwise adjusted to achieve a desired rate and pattern of development. Funding may also be required to stimulate the adoption of these development opportunities.

While improvements in market availability and farm profitability will be needed to bring about any significant increase in agricultural production, the Agricultural Land Base Study has shown that Alberta's land and water resources should not restrict the future growth of the agricultural industry.

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